MAY 5 1910

JOURNAL OF ELECTRICITY

POWER AND GAS

Devoted to the Conversion, Transmission and Distribution of Energy

Entered as second-class matter May 7, 1906, at the Post Office at San Francisco, Cal., under the Act of Congress March 3, 1879

VOL. XXIV NO. 18 | SAN FRANCISCO, APRIL 30, 1910 | PER COPY, 10 CENTS

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VOLUME XXIV SAN FRANCISCO, APRIL 30, 1910. NUMBER 18

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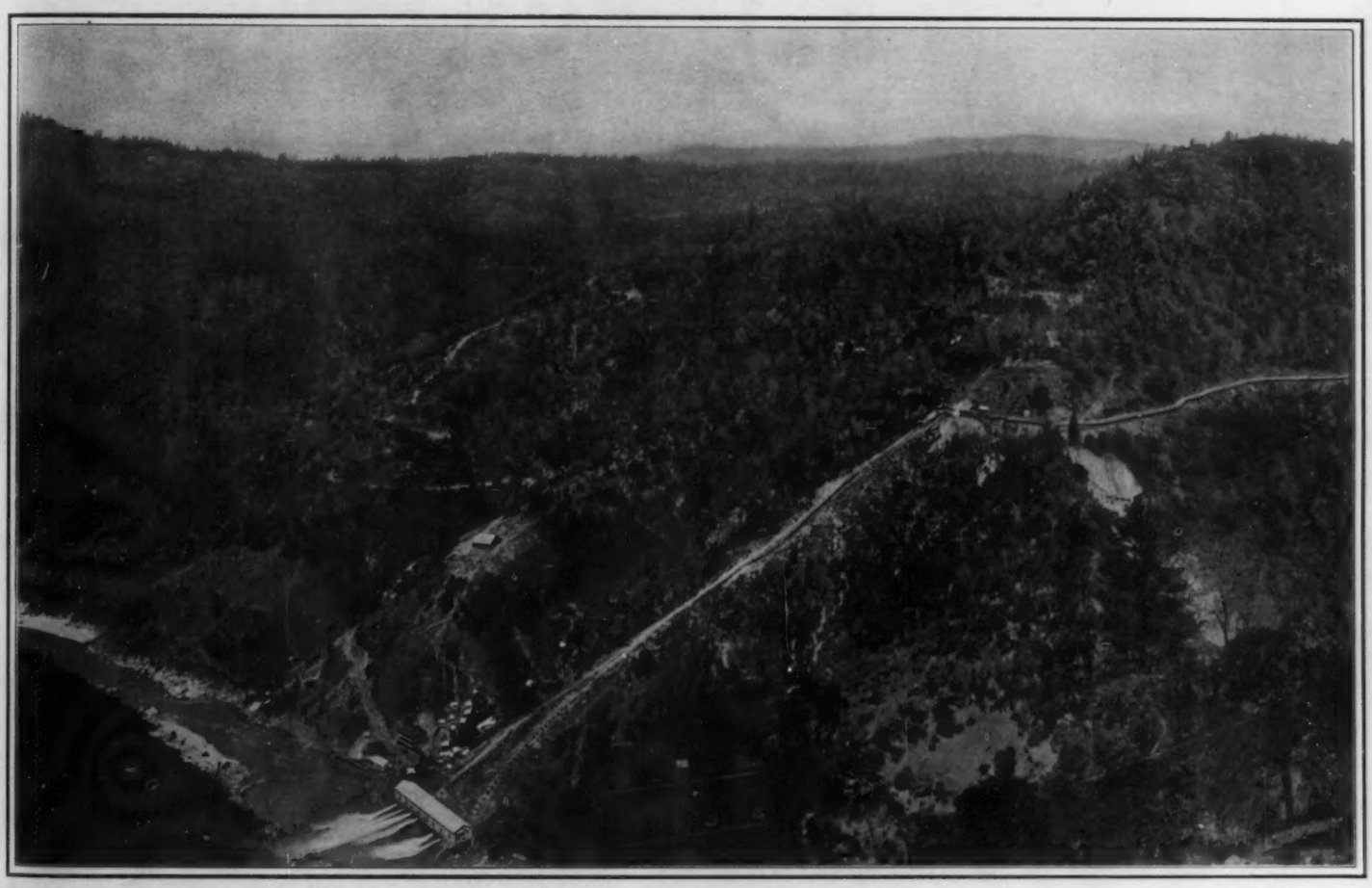
THE STORY OF COLGATE AND YUBA POWER PLANTS

BY ARCHIE RICE



The Colgate Plant on the Yuba River.

Archie Rice

Nowhere in the world, probably, is a huge, modern, hydro-electric development more graphically shown at one glance than in a general view of the famous Colgate power plant, on the Pacific side of the Sierra Nevada mountains, in the northeastern part of California, some one hundred and forty miles by power-line from the cities of San Francisco bay. There, where the Yuba River gushes down between thousand-foot evergreen ridges in Yuba County, a long stone building squats close along the water's edge, with its back to a steep, rugged slope. Straight up that incline for a quarter of a mile the eye traces five enormous black pipe-lines that obviously come into the power house from a great wooden flume that is seen clinging high along the side of the mountain.

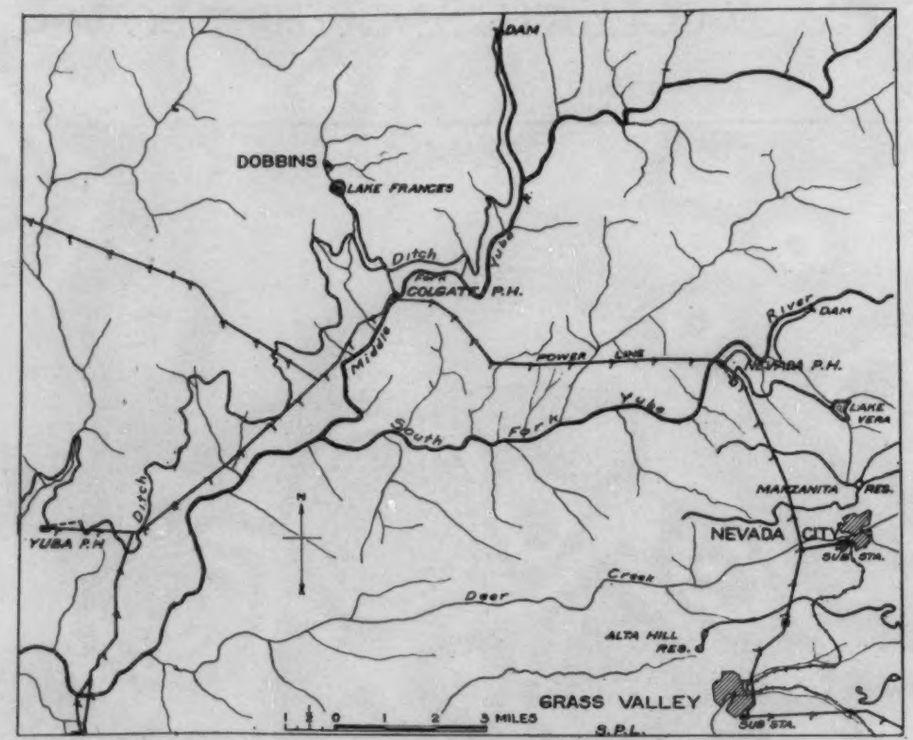
Eight miles upstream from the power house is a massive, granite diverting dam across a narrow point in the river canon. The river has hurried over its

rocky, gold-sprinkled bed for thousands of years, descending by many little rapids in making an aggregate drop of one hundred feet to the mile. But the big flume that ingenious man devised winds majestically along the precipices and slopes like a scenic railway, and by nice engineering preserves a gradual fall of twelve and two-thirds feet to the mile. So, by the time the flume water has arrived opposite the power house it is ready to take a single perpendicular drop of seven hundred and two feet, or more than four times the height of Niagara Falls.

That gentle diversion of an impetuous river to produce an artificial fall at a given spot and there convert the water power into definite energy, spouting from nozzles against water-wheel buckets, is the main principle of hydro-electric engineering. The greater the fall and volume of water, the greater the hydraulic power that can be obtained to turn the wheels of the big magnetic devices that generate electric current.

That remarkable flume is seven and six-tenths miles long, and it is seven feet wide and five feet deep. It is almost level full of water that rushes along with a flow of 12,000 miner's inches; a flow so swift that a man must be a Marathon runner to keep up with it; and so powerful that neither man nor animal ever gets out of it alive, if, perchance, the feet slip off the double plank which runs midway along on top of the cross beams that strengthen the box-like structure. Day and night watchmen walk those planks that are laid almost on the surging rush of water and half a thousand feet above the bed of the river.

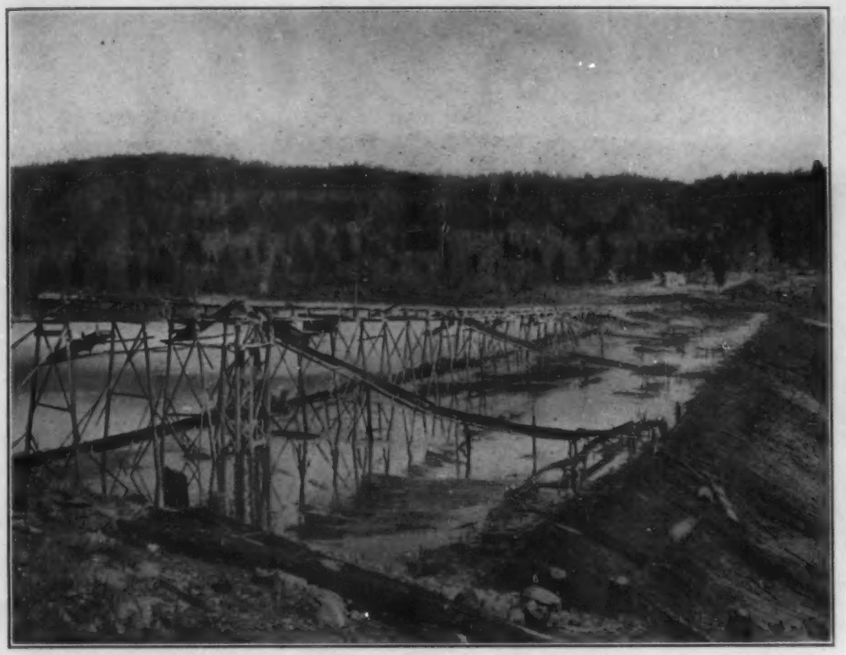
When that flow of 18,000 cubic feet of water a minute comes down the hillside through all five of those thirty-inch pipes, tapered to nozzle-ends the thickness of a man's arm, the water shoots out in four-inch streams more terrific in force than any fire engine ever produced, escapes with an impulse so great that you can strike the stream with a big sledge-hammer as though on an anvil. That silvery projectile of solid water will rend a board to splinters, or hurl a big rock clear across the canon and shatter it to fragments in transit. Such is the force of those condensed columns of water. They strike a horizontal undershot blow into the powerful steel buckets of the man-high impulse wheels, down under the power house, with a force of three hundred and four pounds to the square inch, a steady three-hundred-pound blow on every little space the size of a silver quarter-dollar, a constant ten-ton thrust against each water wheel. Such is the power of the water at the Colgate plant. And that tremendous battery of shooting streams turns the wheels that steadily generate nearly 20,000 electrical horsepower. Lessening demands for electric energy way off down in the big cities automatically deflect those movable nozzles so that only part or none of the stream strikes the buckets. And what escapes shoots free far across the canon.



Map Showing the Colgate and Yuba Power Plants, the Ditches, Dams, Rivers and Power-Lines.

The Water Supply.

The catchment area above the dam—the high mountain ridges and forest slopes that drain the winter's rainfall and the summer's myriad springs and melting snows down into that particular canon—is



Lake Frances in the Making.

A Section of Rapid-Flume from Lake Francer

Inverted Syphon carrying Brown's Valley Ditch across Canyon below Yuba Power Plant.

The Stave Pipe-Line from Lake Frances to Colgate.

Clearing the Ground for Yuba Power Plant

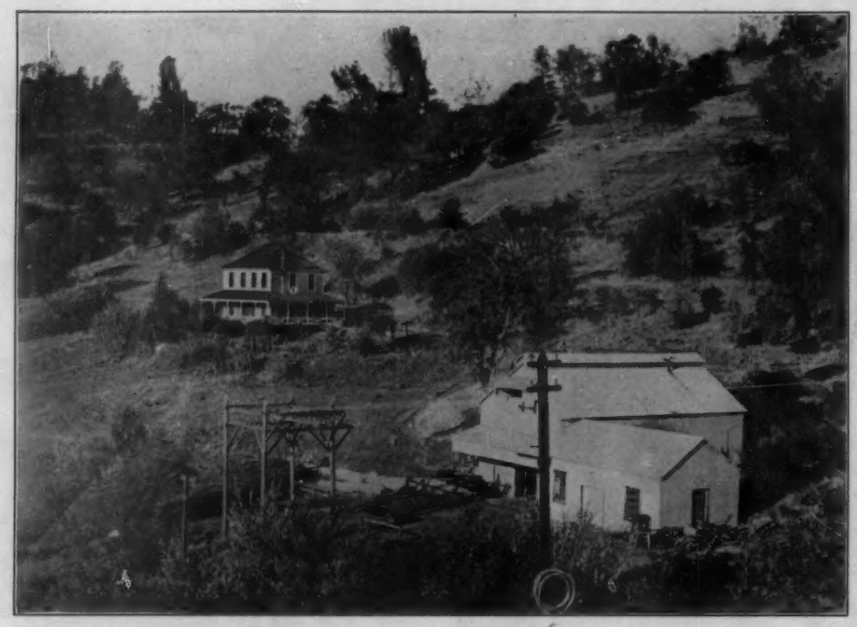
equivalent to a square tract of country a little more than twenty-three miles on each of its sides.

But to make sure of constant water power for the Colgate plant, to guard against any unforseen subsidence in the river's flow above the dam or against any accident to that long, wooden flume—through breakage, landslides, snowslides, or forest fires—there is an artificial lake up between the ridges, off to the left, two miles and a half behind the power plant, and three hundred and eighty-two feet elevation above the top of those five big pipe-lines that come down the ridge to shoot water against the wheels.

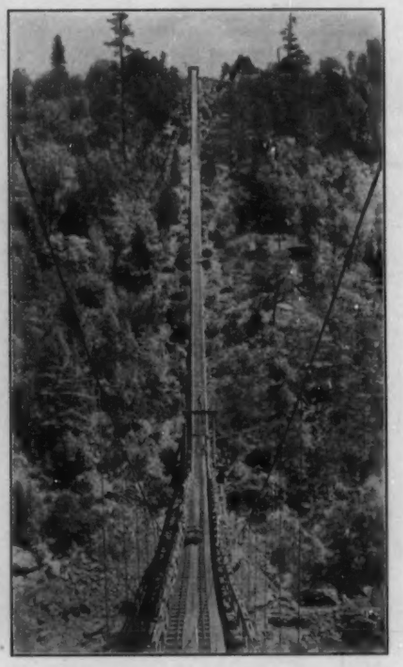
It is called Lake Frances, and it covers an area of one hundred and five acres and holds 92,870,000 cubic feet of water all the year round. It is as large as about fifteen city blocks. During the rainy season it catches the water drainage from the minor surrounding slopes, but its principal source of supply is the river flume itself.

The Yuba Power House.

Eight miles below the Colgate power house is the Yuba power plant, with a generating capacity of nearly one thousand horsepower. Historically, commercially, and sentimentally this smaller enterprise is the parent of the great Colgate plant. They produce and turn current into the same long-distance



The Yuba Power House and (at the Left) the Superintendent's Residence.



The Tramway and its Suspension Bridge.

power-line, and they get their water power from the same source. A generous part of the flume flow must ever go on past Colgate to preserve the original rights of the Brown's Valley ditch. Twenty-two miles of winding ditch brings the flow to a point above the little Yuba plant, and there it takes a perpendicular drop of two hundred and ninety-two feet through a single big forty-two-inch pipe. That water gushes against the Yuba impulse wheels and then, its fighting force expended, it flows gently on through twenty-five miles or more of winding ditch, traversing Brown's Valley, and doing only the quiet and peaceful work of irrigating lowland orchards and farms.

California's Wealth of Water Power.

To understand why it is that California is so wonderfully rich in water power you must bear in mind that there is a dozen or more of rivers rushing down from sources high in the lofty Sierras. Wherever water can be diverted and made to flow gradually along the side of a river canon to produce a single plunge of several hundred feet, there power can be developed to run an electric generating plant. How splendidly California is supplied with these steep rivers is indicated in the accompanying table, which gives the foot-drop to the mile for several well-known eastern rivers and for some of those in California. In this connection it will be recalled that the Yuba river slopes average of a hundred feet to the mile between the dam and the Colgate power house, and that the diverting flume is given a drop of less than thirteen feet to the mile. That flume slope is much greater than is really necessary. The mighty Mississippi goes to the gulf with a drop of only a little more than seven inches to the mile.

The steep descent of most of the California rivers enables power developers to locate more than one plant on the same diverted water system by leading the discharged water from the upper plant down by easy gradients to some point where another big drop can be produced.

River,	Miles Long.	Feet Descent.	Foot-drop to Mile.
Eastern:			
Mississippi	2,300	1,500	.6
Ohio	1,000	700	.7
Missouri	2,340	4,000	1.7
Connecticut	375	2,000	5.3
Kennebeck	150	1,000	6.6
Rio Grande	1,800	12,000	6.6
Hudson	300	4,300	14.3
California:			
Calaveras	68	1,000	14.6
Sacramento	400	7,000	17.5
Feather	136	4,678	34.4
Tuolumne	155	8,000	51.6
Stanislaus	113	8,000	70.8
American	118	8,500	72.0
Yuba	90	6,700	74.4
Cosumnes	93	7,500	80.3

Early Hydro-Electric Developments.

Having in mind now the peculiar fitness of California rivers for mountain power-development, it is easier to see how the plants progressed after a start was successfully made and long-distance transmission had become commercially possible. That the mysterious current could, without too much loss in power, be sent through a wire to a considerable distance from the place where it was generated was first demonstrated to the world in 1886 by the hydro-electric plant at Tivoli in Italy sending current seventeen miles to the city of Rome.

Thirty or forty years before that Italian plant had proven the city value of distant mountain water power California's miners had constructed amazing diverting ditches and had begun using the flow of mountain rivers to operate terrific hydraulic giants in tearing away hillsides and dissolving them to mud and stones in quest of settling gold. After the Sacramento river channel had been alarmingly filled in with these torrents of man-made mud and the farmers in the lowlands had been successful in having laws passed against unchecked hydraulic washings the costly mining ditch systems looked like a dead loss to those who had put money into their construction.

Next came irrigating schemes and a period of partial usefulness for the old mining ditches.

The Old Brown's Valley Mining Ditch.

Then came hydro-electric power plants! The very flume system that now supplies Colgate, the same ditch system that runs on more than a score of miles and supplies the Yuba plant and goes another score further with irrigation, has been in operation for years as the Brown's Valley ditch, carrying water for hydraulic mining in Brown's Valley.

In the spring of 1895 the city usefulness of distant water power was first demonstrated in California with the completion of the power plant on the edge of the American River at the town of Folsom. Its electric current was successfully sent through a twenty-two-mile power-line into the city of Sacramento. Then, in February of 1896, after five years of effort in acquiring and developing the necessary water power, the Nevada power plant was started on the edge of the south fork of the Yuba River, down in a deep mountain ravine in Nevada County. And then that plant began sending electric current through an eight-mile power line to the towns of Nevada City and Grass Valley and their famous deep gold mines.

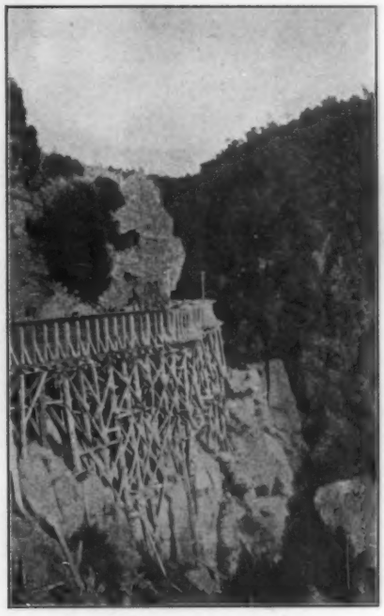
Eugene J. de Sabla, Jr., was the principal man behind the little Nevada plant on the south fork of the Yuba, and John Martin had taken the contract for its general construction.

Hydro-electric power was a new thing, but it did not take de Sabla and Martin long to see that it was a good thing, and that not many miles away was that Brown's Valley ditch and a prospect of taking a good fall out of it. So, in September of 1897, they incorporated the Yuba Power Company, and had as a partner with them R. R. Colgate of New York City. Martin and de Sabla were San Franciscans.

Not a day was wasted on this new scheme. Within the record-breaking time of four months and five days after they decided to build the Yuba plant the thing was completed, was generating electric current, and, at the then almost appalling potential of 16,000 volts, was sending it on down twenty-two miles to the city of Marysville on the Sacramento River, where the Yuba joins the main stream.

It was in April of 1898 that this Yuba plant began operating. They had constructed a frame building covered with zinc-coated corrugated iron, and it stands there yet in a narrow, lonesome, tiny, upland valley between Dry Creek and the Yuba River and eight miles from the little town of Smartsville. The original installation then consisted of three 300-kilowatt Stanley generators. One of these generators has since been removed, leaving the plant with two, and a productive capacity of a little less than one thousand electrical horsepower. A big forty-two-inch pipe eight hundred and fifty feet long descends the oak-dotted hillside and ejects its flood of water through a large box-like compartment along the outside of the power house, the undershot flow revolving the two sets of wheels that turn the generators inside the building.

The Yuba River Dam from which Colgate Is Supplied.



A Difficult Point.

Within a year after the completion of the Yuba plant business had so increased and electric prospects so expanded that the promoters reorganized with a capital of $1,000,000 with which to buy out the Yuba Power Company and go in for bigger hydro-electric development further up on the Yuba River. They called this new concern the Yuba Electric Power Company.

With an eye still on the course of that Brown's Valley ditch, they picked out a place on the middle Yuba where they could get more than twice the fall they had down at the little Yuba plant.

Site For the New Plant.

The spot selected was where the old Missouri Bar trail crossed the Yuba on the route between Dobbins and French Corral. Then they engaged W. R. Eckart to give his expert experience to the development of the flume for a greater flow. So the old flume that had wound along the canon side and been in use for ten years was supplanted by one almost twice as big, erected right along above it; and the diverting dam up-river on the north fork of the Yuba was strengthened and raised ten feet in height. As the dam stands today it spans one hundred and sixty-seven feet across the ravine and is forty feet high. It has a long wing sweep that diverts the water through concrete headgates, which open into the great flume.

Day after day, day after day, lumber poured down that chute tramway out of the sky, and the flume slowly stretched on down the canon, mile after mile, until they had used up just 8,000,000 linear feet of lumber, if you know what a lumber pile that makes! In places they blasted away the solid granite cliff and made a shelf, on turns they used long steel rods and bolted the flume securely to the native granite wall, and all along the way they braced it and gave it a foundation like a railroad trestle.

Then every two miles or so they scooped a little shelf and built on it a small house, with a porch overlapping the flume. These houses were the permanent camps for the flume-tenders, the forest-fire crews, the repair gangs of many carpenters that work along that structure for weeks in the summer. Later

Suspension Bridge across Yuba River at Colgate

Burro Brigade Packing Dynamite and Cement.

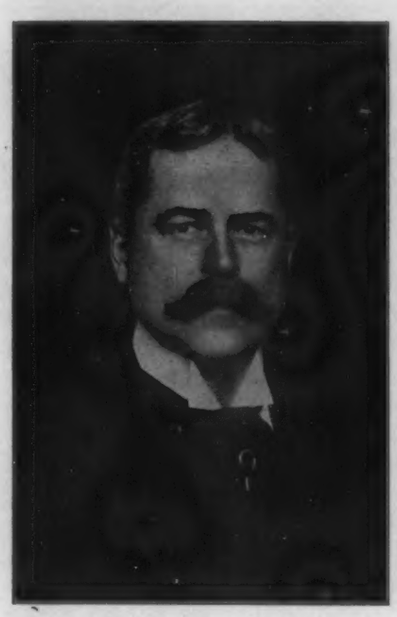
A Glimpse Across Lake Frances.

The construction of the dam was not so difficult. The native granite was right there. Only tools and dynamite and cement had to be packed up the river canon. But the building of those eight miles of flume, with all the necessary scaffolding, trestles, and the use of tons and tons of lumber was a real problem. Lumber mills were a long way off, and mountain roads steep. Ten miles across the thousand-foot ridges to the eastward of the dam was a good forest region, over in Nevada County, thick with cedar, spruce, yellow pine, and sugar pine of good size.

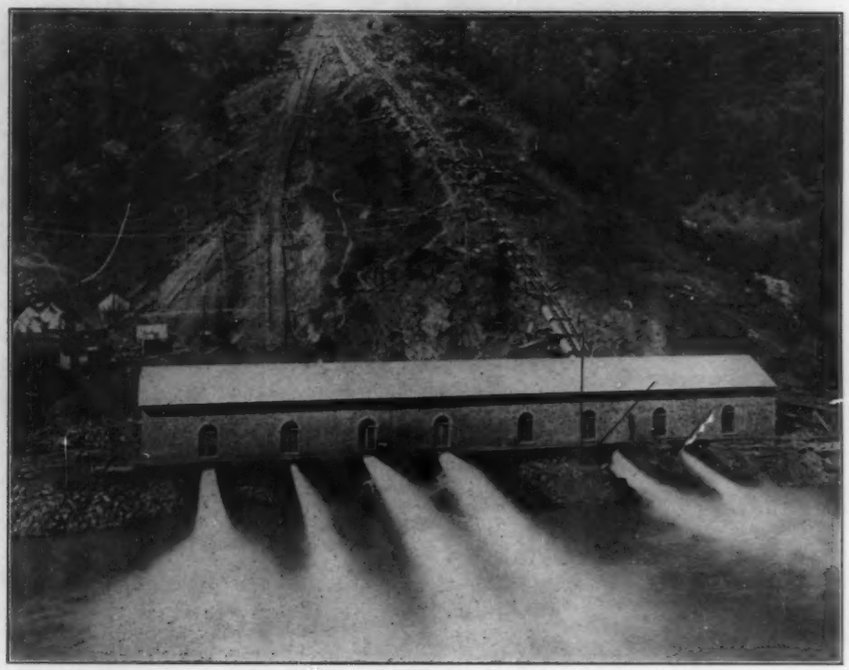
There a sawmill was established to turn out lumber for the new flume. The company still owns and operates that sawmill. They cut 11,000,000 linear feet of lumber, and then picked out the very best of it, the hearts of the logs, to use for the flume. Across the highlands that lumber was hauled and on to the top of the ridge, almost above the dam. Then they built a steep tramway coming down the mountain 1,275 feet like a narrow ladder reaching from the depths of the gorge right up to the blue vault of heaven. And the lower end of that ladder they curved into a dizzy suspension bridge that would deliver the well-strapped little carloads of lumber right over on the flume-side of the canon, where a space had been gouged out of the rock as a sort of landing shelf.

they stretched along the side of the flume a private telephone line with numerous stations from which to sound an alarm or to notify the plant that the flume had broken and that the water power would cease coming. One day a workman in a repair gang slipped and dropped a box of dynamite into the flume and then rushed to the telephone to warn the fellows down at the power plant to "look out" as it was hurrying their way. But the long watery trip must have safely soaked and diluted the explosive before it reached the penstock gratings and screens.

While the carpenters were rebuilding the great flume other gangs of workmen were carving a steep mountain road down from the direction of the little hamlet of Dobbins to deliver the heavy machinery. As the loads were to come down, the graders did not bother about any future loads that might have to be hauled up that terrible slope. So that road remains as a tedious, toilsome climb. While the roadmakers and the flumemakers were busy masons were getting ready the building. The high-walled canon daily resounded with the cannonading of dynamite where all three gangs were blasting out rock and clearing a way for operations. They dug down forty and fifty feet to get a virgin granite base on which to erect the Colgate power house, and then they built it solidly of granite and cement and lined it inside with cement



Romulus Riggs Colgate.



The Colgate P wer House.

and braced it with steel girders. The building, now twice its original length, is two hundred and seventy-five feet long and forty feet wide, has a cement floor, and it is absolutely fireproof.

The original part of the Colgate plant was completed and current from it was sent through sixty-one miles to Sacramento the 5th of September, 1899.

But even while operations were hurriedly going on to complete the Colgate plant electric demands so increased that the promoters began to see something of the great possibilities they were opening up for the valley and populous districts of California, where power was needed and wanted. So, in June of 1900, they reorganized again, this time with their capital stock $5,000,000, instead of $1,000,000. They called the new enterprise the Bay Counties Power Company, and, September 1st, 1900, they absorbed the Nevada power plant, over on the south fork of the Yuba. Eugene de Sabla was chosen as the first president of this enlarged concern, with William M. Preston as vice-president and attorney, and C. A. Grow as secretary and treasurer, and the directors were J. C. Coleman, Richard M. Hotaling, R. R. Colgate, and George A. Batchelder—all San Franciscans but the last two, and they were New Yorkers, Batchelder being the representative of an eastern banking house that had advanced $2,250,000 for the project.

Colgate Plant Doubled.

Within two years after the completion of the original Colgate plant the building was doubled in length and in producing capacity by an addition to the upstream end. The 27th of April, 1901, the Colgate plant did a historic thing in California power development. That day through its twin wires—one aluminum, one copper—it first transmitted high-voltage electric energy way through to the city of Oakland, a distance of one hundred and forty miles by the pole-line; and yet not a newspaper mentioned that epoch-making fact. Again the company reorganized and expanded to keep pace with business prospects, and (March 1st, 1903) took the name California Gas and Electric Corporation, with R. R. Colgate as president. And finally (January 2d, 1906) it became a part of the great Pacific Gas and Electric Company, with its present total of fourteen electric plants and eighteen gas works.

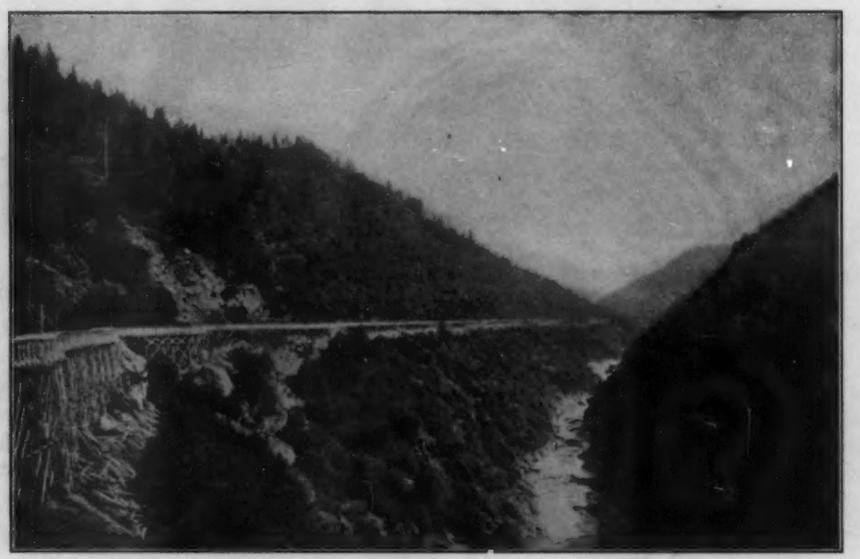
The Equipment at Colgate.

As it stands today the Colgate power plant contains six great electric generating machines and twenty-three transformers, and it has radiating from it five different high-voltage pole-lines traversing mountain ridges and valleys for more than 450 miles, and carrying enough big copper wire to span the American continent from San Francisco to New York, Two lines run through to Oakland, two go over the ridges into Nevada County, and one extends to Sacramento, all of them carrying a glisten of gold and silver threads spun as far as the eye can see through the clear air above the green Sierra ridges.

There are eleven impulse wheels at Colgate taking the drive of water from the five great pipe-lines that are anchored to solid cement blocks down the mountain side. Three of these wheels are eight and a half feet high, and turn at the rate of two hundred and forty revolutions a minute. Four of them are an inch under six feet high, and make three hundred and sixty revolutions a minute. Along beneath the building its entire length is a concrete-lined subway seven and a third feet wide by eight feet high and carrying all the bus bars and wiring of the entire station.

The installation at Colgate consisted first of three 900-kilowatt, 2,400-volt, sixty-cycle, three-phase Stanley generators and one 720-kilowatt, 2,400-volt, 133-cycle, two-phase Stanley generator. But when the

Interior View of Colgate Power House.



Four Miles of the C lgate Flume in Sight.

plant was enlarged a year later a 2,000-kilowatt, sixty-cycle, three-phase, 2,300-volt Stanley generator was added; and in 1906 the 720-kilowatt generator of the original installation was moved and established at the upstream end of the building, and in its place was set a new 5,500-kilowatt, sixty-cycle, three-phase, 2,300-volt Westinghouse generator. All these generators are still in use.

The hydraulic installation consisted at first of two thirty-inch pipe-lines, with Risdon impulse wheels, two wheels on a shaft for each of the four generators. Later two more thirty-inch, cast-iron pipe-lines and one thirty-inch riveted steel pipe-line were added, with twin Risdon impulse wheels to drive each of the additional generators. And this general hydraulic equipment is also still in use.

The transformers at first consisted of four banks, and three banks were added when the plant was enlarged. These transformers have been used in raising the generated voltage from 2,400 for delivery through different power lines first at 24,000 volts, a year later at 40,000 volts, two years later at 50,000 volts, and during the past seven or eight years steadily at 60,000 volts for all the high-tension lines. By thus making the voltage higher the electric energy may be more economically sent through a smaller and less expensive copper wire and then at the delivery end, by means of reducing transformers, it may be lowered for various commercial needs. Thus experience has shown that in long distance transmission of electric energy it is cheaper to have more tranformers at both ends of the line and be able to send high voltages through the many intervening miles of smaller copper wire, since pure copper runs into money.

All the transformers in the Colgate plant are oil-insulated and water-cooled. The exciters originally installed at Colgate are still in use after nearly eleven years' service.

The generator and transformer switches originally installed at Colgate in 1899 were of the air-break, knife-blade type. But when the plant was enlarged in 1900 they were all changed to Stanley oil-switches, and a little while afterward Stanley high-tension switches were put on the 40,000-volt lines. Two years later all the Stanley switches were replaced by Kelman switches, but the Kelman switches lasted only about four months. One was opened on a short circuit and caused a fire and a lot of damage in the building. So in 1904 Baum oil-switches were placed on all the high-voltage lines, and they have been in constant use ever since. These switches were invented by Frank G. Baum, formerly electrical engineer and then superintendent of the Pacific Gas and Electric Company.

EXAMINATION FOR WIRELESS TELEGRAPH OPERATORS.

The United States Civil Service Commission announces an examination on June 1, to fill three vacancies in the position of wireless telegraph operator at $1,200 per year each, in the Philippine Bureau of Posts.

STEAM

THE DISEASES OF BOILERS.[1]

BY F. S. ALLEN.

Boilers are heirs to nearly as many diseases as the human family. Some are crippled from birth, owing to errors in construction. The most marked and important of these congenital troubles is the one that makes itself known by the failure of the lap seam along a line which passes close to the rivet holes, but usually does not enter them, except when radiating branch cracks are present.

There were few failures from the lap-joint crack when iron plate was exclusively used in the construction of boilers, and this was doubtless due to two main facts,—first, the fact that the plates then used were small, and second, the fact that steel (which is now used almost universally for boiler shells) is much more likely than iron to develop this particular defect.

Certainly the workmanship was no better in the days of iron than it is now, and in fact it was, as a rule, probably distinctly inferior; and while the pressures that were carried were less than they are today, the boilers were no better adapted, by reason of design and construction, to bear those lower pressures, than modern boilers are to bear the higher ones that we find today.

A more important circumstance was, that in the use of iron it was impossible to obtain large plates. Thus boilers 4 ft. or more in diameter were made with two plates to a course, and a boiler 16 ft. long was usually built in five courses, and never in less than four. The girth seams doubtless stiffened the plates, for in the examination of a great number of boilers that had exploded by rupture of the seams it was found that the fractures commenced midway between the girth joints. In hundreds of cases, too, the main line of fracture has developed lateral branch cracks, which have been detected by the inspector because they showed just beyond the edge of the inner lap; and then by cutting out rivets and opening the joint longitudinal fractures have been discovered, without actual explosion of the boiler. Cracks discovered in this manner are always in the center of the course. Furthermore, in destructive tests of boilers we have found the distress to begin, and failure to occur, at the middle of the course. All of these facts show the importance of the stiffening action of the girth joints upon the shell.

Passing now to the consideration of the effect of the material itself, we note, first, that iron withstood the severe treatment of whipping down the ends of the plates with sledges—this practice having once been nearly universal in boiler shops. The only remedy for this is to provide a massive former, which, by heavy pressure, finishes the ends of the plates and brings the laps to as nearly a circular form as possible, though even with this precaution there is always some flattening at the lap.

Steel appears to resent the sledge-hammer treatment, and it is also sensitive to the slight local movements that occur near the joint, owing to variations of pressure in the boiler, and to the fact that the contour of the boiler shell is not truly circular near the joint.

Another defect that can be produced in riveted joints is due to neglect in adapting the pressure that is employed for closing the rivets, in hydraulic riveting (which is the best method of riveting), to the nature of the joint that is being made. The pressure that is maintained upon the accumulator should be varied according to the diameter of the rivet that is to be driven, and the thickness of the plate of which the shell is to be made.

Ruptures of plates from these causes occur with little reference to factors of safety, or to the age of the boiler. They sometimes develop within a year or two, while in other cases they do not appear until after several years of service.

Alteration of the structure of the boiler, under the influence of stress and temperature, is undoubtedly the cause of failure in many cases, and evidence of the fatigue of metal, which admittedly occurs in all classes of machinery, is found in boiler plates. Fractures in the plates, away from the seams, have been found occasionally, and surface cracks, either internal or external, may develop in the shell, the plates being then brittle enough to be readily broken up with a hammer when they have been removed from the boiler. Such cracks are not so frequent, in the central or free parts of the plate, as they are near a flange or some other rigid connection, where the effect of the movement of the plate may be localized. The localization of strains in this way has been the cause of frequent failure or fracture in some types of boilers, with the result that expensive repairs have been required, and in many cases explosions have resulted.

We also find evidence of profound alteration of the structure of the material in boiler tubes, these often losing their ductility after a few years of service, even though they may have been reasonably ductile when new. Undoubtedly the skelp from which these tubes were made was of an inferior quality; and the alteration in their structure, with the resulting liability of fracture, is probably due to the temperature to which they are exposed, rather than to the pressure.

Of late there are many defective bolts found among those that are used for holding the tube caps on the manifolds in some types of water-tube boilers. This is a dangerous defect, as most of these boilers are operated under high pressure, and the caps are upon the outside, so that the failure of the bolt releases the whole contents of the boiler into the fire-room. This matter is so serious that it has been taken up by one of the large electric-road operators, and chemical tests have been made of the various bolts in actual use, and of the bolts purchased. The number of defective bolts found during the past year was very great, while ten years ago it was the exception to find any such bolt defective. I cannot say what the result of the investigations now going on in my department, and among steam users, will develop, but from personal investigation I believe that the bolts that have been used for the past few years are of steel, and evidently they are commercially-made bolts. The ductility of many of

[1]Condensed from an address before the New England Association of Electric Lighting Engineers.

the defective bolts is so far reduced that, though they are an inch in diameter, a blow from the light hammer used by the inspector would snap them off with a single blow. Many were also found to be cracked partially through.

With regard to these bolts I would say that the remedy, in my opinion, would be to use bolts that are forged from the very best quality of Swedish iron. These bolts are not subject to alternating or intermittent variations of stress, and hence it appears probable that the change in molecular structure that they undergo is to be ascribed to the natures of the material from which they are made, the alternation taking place as a result of the temperature to which they are exposed.

One other cause of rapid deterioration and loss of efficiency in boilers is the formation of incrustation and scale. Water-tube boilers are peculiarly sensitive to this, as their tubes are liable to become overheated, and the thin material of which they are made then becomes subject to distortion, where the relatively heavy plates of a boiler shell would remain comparatively unaffected. A great many cases of this kind occur yearly, and the rupture of the tubes is not infrequent.

Some twelve years ago several tubes ruptured in one of our best equipped and largest electric plants, and overheating of the lower tubes was noted in all the boilers. Many were quite badly affected, and others not so seriously. Some of the least affected tubes were selected, and many specimens taken from there were sent to Watertown, Mass., for test. The results were of considerable value. The rapid deterioration of the tubes was considered to be largely due to the feed water and to the nature of the incrustation. A change was made in the water supply, and I do not recall any trouble with tubes experienced at this plant since.

The failure of tubes in water-tube boilers is not infrequent. It is sometimes due to defects in construction or in welding; but I have noted one peculiar fact, which has impressed me considerably, and that is, that except in cases in which the weld was defective, I have not noted a single case in which the failure occurred directly at the bottom of a tube. This fact may be of little interest, but it has impressed upon my mind the view that structural change in the material, leading to the failure or splitting of the tube, takes place a little towards one side of the bottom, or (say) at "about eight o'clock" in the circle of the tube.

The increase of temperature attendant upon the use of higher pressures has brought about some new developments, detrimental to boilers, in connection with the formation of scale, and this is especially true in the fire-box type of upright boilers. There is little space, in these boilers, for the deposit of scale upon the tube sheets directly over the fire, and in view of the large amount of heating surface and the normal evaporation, the formation of scale must be very rapid upon the tube sheet, especially when the feed water is at all brackish. Two marked instances are worthy of notice, the observed results seeming hardly credible. In both cases the boilers were nearly new, and were of good construction, and working under proper factors of safety. Leakage around the tubes developed quite early.

In one of the cases the trouble occurred in a battery of very large boilers of this upright type, operating at a pressure of 170 lb. per sq. in.; the owners in this case (as well as in the second one, presently to be noted) having a large number of boilers of the same type operating at 125 lb. There had never been trouble from scale, although in the older boilers, operated at 125 lb., there was a considerable deposit of mud which was readily removed by periodical washings. No trouble from leakage had been experienced from this sediment at any time, in any of the boilers of this plant, until the new high-pressure boilers were installed for electric power; and the plant was thoroughly modern and up-to-date, and everything of the best construction. An examination of the high-pressure boilers, after the leakage around the tube ends had developed, showed a thin, hard coating of sulphate of lime over the whole tube sheet, and making a slight fillet around each tube. The coating resembled an enamel lining more than a scale, owing to its extreme thinness, and its adherence to the plate. The fact that the same water had been used in boilers in operation in this plant for over twenty years, and that no trouble had occurred from scale or deposit, made it difficult to persuade the engineer that the leakage was due to the feed water, and to scale formation; but by the judicious use of solvents the enamel-like coating was finally dissolved, and no leakage has occurred since, solvents being now used to prevent further deposition of scale.

The second case was similar to the first, but the plant was many miles away, and used an entirely different water. Nevertheless, the same kind of action took place in the boilers that were operated at 160 lb., although boilers in the same room had been operated on the same water, with entire success, for twelve years, at 125 lb. This second case also yielded to treatment, and the affected boilers have since been running at their maximum capacity without leakage or trouble of any kind.

By way of explanation we may assume that the difference between the temperature, due to 125 lb. pressure, and that due to 160 lb., was sufficient to cause the precipitation, in each case, of a small quantity of sulphate of lime, which, at the lower temperature, had remained either in solution, or in suspension with the mud that had been washed out so readily.

The importance of eliminating all lubricating oils from boilers is almost too well known to be worthy of mention, yet oil continues to be a great source of injury and destruction, where the water of condensation is recovered from the exhaust steam, and used over again in the boilers. Separators are put in, having a nominal capacity based upon the area of the exhaust pipes, without reference to the volume of steam that these exhaust pipes are to carry. This is a grave error, in many cases. Separators have capacity, as well as other machinery; and in installing an oil separator, care should be taken to ensure for it a capacity sufficient to handle the full volume of steam passing through it.

There also seems to be much difficulty experienced in removing oil from boilers, when it has once

effected an entrance. This can be done readily, in some types of boilers, by swabbing the sheets and tubes with a mop dipped in kerosene oil, after taking the highly important precaution of extinguishing all open lights about the boiler, as a measure of safety. In other cases, where the boilers are inaccessible for mopping, they can be boiled out with a strong solution of soda ash (or caustic soda if the soda ash does not prove effective), with a generous addition of kerosene oil, the pressure being maintained at half or two-thirds of the regular working pressure for from twelve to twenty hours. After this treatment the oil can usually be washed out in the form of a curd.

Corrosion, another boiler disease, is not so common today as formerly, but it still is an active enemy of steam boilers. I say it is less common than it was formerly, because a great change has been made, in the last few years, in the types of boiler in general use, and those that are at present most common are less liable to corrosive action than were the drop-flue, hammer-head, and similar types having a poor circulation at the bottom. We still have with us some types in which there is a tendency to corrosion, and no universal remedy can be relied upon. Instead, each case must be carefully investigated, and a remedy applied that is appropriate to the cause of the difficulty. Where the water is pure and the boilers are operated intermittently, corrosion is frequently found in the form of pitting. This action takes place very often in pumping stations, and in power plants and electric stations where the fires are kept banked for long periods, with the water in the boilers quiescent, and far less often in boilers that are always in active service. Boilers that are used exclusively for heating purposes suffer more than any others from pitting.

Once started, corrosion is likely to go on until the material of the boiler is destroyed, unless measures are taken to check it. When corrosion is observed in connection with the use of a pure water, one of the best methods of treatment is to keep the water alkaline with soda ash, for this tends to check the corrosive action, and the soda does not injure the boiler.

Care should be exercised, in selecting feed water for a new plant, or for a new location of a plant, to see that the quality of the water is good. Nitrates in the water should be especially avoided, as they are especially troublesome and dangerous. The presence of nitrates commonly results in the formation of a light scale coating, under which an active destruction of the material of the boiler goes on, the plates and tubes becoming wasted away, and the braces and rivet heads cut off.

In certain types of boilers the breakage of staybolts is a frequent and annoying, as well as expensive, occurrence. Such bolts are often drilled with a 3/16-in. hole, which either passes through the entire length of the bolt, or at least goes in deeper than the thickness of the outside sheet; and such holes are supposed to give absolute safety, so far as the detection of broken bolts is concerned, the theory being that steam will escape from the end of the bolt as soon as fracture has occurred, and thereby call attention to the trouble. The drilled hole is not to be relied upon, however, because, in the process by which the staybolt fails, the fracture will creep into the bolt slowly, and when it first encounters the hole, moisture from the boiler will leak out through it in very slight quantities, and evaporate without attracting any attention. In evaporating, however, the moisture leaves behind it a certain amount of solid matter, and this accumulates until it forms a hard, baked residue, completely choking the opening in the center of the bolt, so that the apparent absence of leakage leads to a sense of security which is far from corresponding to the actual facts. Many bolts that have been drilled, for the purpose of providing security against undiscovered fracture, have been found to be completely broken off, and many others have been found to be partially broken, without any noticeable leakage occurring in either case. It will be plain, therefore, that if any reliance is to be placed upon the drilled staybolt, it is important to ream out the holes frequently, and keep the openings free. The breakage of staybolts is sometimes due to circumstances connected with the environment of the boilers, to their exposure to injury from external causes, to strains from varying temperature and differential expansion, and to faulty construction or poor material in the bolt.

Many of the minor diseases of boilers, such as rapid losses of ductility, and development of incipient fractures at different parts (as at the girth joints in the plain tubular boiler), may be due to the conditions under which the boilers are operated, such as to the varying level of the water, and to the introduction of cold feed water, or to blowing down the boiler under high pressure and leaving the drafts on, so that cold air may be drawn through and so give rise to serious unequal contraction, or to pushing the fires too hard in raising steam from cold water. Several strains, resulting in leakage at the seams and around the staybolts and tube ends of fire-box boilers, are frequently caused by the burning out of the fire under one boiler of a battery, while this boiler is left connected with the rest of the battery, and with the draft full on. All these defects are developed by poor practice or management.

Just a word, in conclusion, about the action of superheated steam. When superheating is done in connection with steam generators, the elasticity and strength of the material are affected if a high temperature is produced, and I look forward with considerable anxiety to the results that may follow when boilers are operated in this way for a term of years. It has come under my own observation, that cast-iron is an unsuitable material to use, for exposure to superheated steam of high temperature. I have in mind some extra heavy valves of the best make, with cast-iron bodies, which, when exposed to superheated steam at high temperature, became badly checked and marked, so that the whole body of the casting had an appearance suggestive of the crazy cracking observed on imperfect crockery. These valves were replaced by others in which soft steel castings of the best quality were used in the place of the cast-iron, and the new ones have thus far, I believe, shown no defects. Fittings or manifolds of cast-iron, connecting superheaters with the generator, should not be indorsed or approved for superheating to 100 degrees or over. In fact, I think that cast-iron for such purposes has already been abandoned in the best practice, forged or wrought iron being substituted for it.

CALIFORNIA FUEL OIL.

BY R. F. CHEVALIER.

Combustion.

Combustion is the phenomena that takes place when chemical reaction occurs between oxygen and a combustible element. The combination is usually accompanied by heat and light. Combustibles are substances that are capable of rapid combination with oxygen to produce light and heat, the oxygen being classed as a supporter of combustion.

The elementary substances entering into the composition of fuel oil are carbon, hydrogen, oxygen, nitrogen and sulphur. The combinations of these elements are always made in definite proportions.

The atomic theory should be understood for a clear conception of this combination. If oxygen and hydrogen combine in the exact proportion of two volumes of hydrogen and one volume of oxygen the result is water. When this water mixture is maintained in a gaseous condition, it will only occupy the space of two volumes, although for its production three volumes were supplied.

According to this theory the smallest conceivable particle of an element that enter enters into combination is called an atom. Molecules are the individual particles resulting from their union. Simple substances as well as compounds have their molecules. A molecule of a simple substance generally has more than one atom in it, but never contains atoms of more than one kind, whereas a molecule of a compound substance always contains more than one kind of atom. The dimension of an atom has never been satisfactorily determined.

The various elements are designated by symbols which are generally the initial of their names, and when necessary for distinction, followed by the succeeding letter. The supposition is that all atoms are of the same size, therefore an element occupying the same volume, at the same pressure and temperature of another have the same number of atoms, but the weight of the two being different. The relation is known as the atomic weight. Hydrogen is the lightest of all known substances and is therefore taken as unity. A given volume of oxygen will weigh sixteen times as much as the same volume of hydrogen. The atomic weight of hydrogen is 1, that of oxygen 16.

The symbol for hydrogen is H, that for oxygen O. When combinations of two or more elements take place, and more than one volume of either enters into the combination, the proportion is designated by a suffix to the symbol of the plural element. For example, the formation of water requires the combination of two volumes or atoms of hydrogen and one volume or atom of oxygen and is represented by H_2O. From this atomic combination the weight of the mixture is easily determined. The atomic weight of H is 1, that of O is 16. We have

2 atoms of H + 1 atom of O = 2 + 16 = 18.

$H_2O = 2H + 16\ O = 18\ H_2O$.

The symbols and atomic weights of the four principal chemical elements found in fuel and the air used for its combustion will be found in table No. 2.

TABLE NO. 2.

Name.	Symbol.	Atomic Weight.
Hydrogen	H	1
Carbon	C	12
Nitrogen	N	14
Oxygen	O	16
Sulphur	S	32

Oxygen is a colorless gas, the universal supporter of combustion and is mixed with the nitrogen of the air in the following proportion:

21 parts O and 79 parts N by volume.

23 parts O and 77 parts N by weight.

A small quantity of oxygen exists in the fuels. Oxygen at atmospheric pressure, temperature 32° F., weighs .088843 lbs. per cubic ft. A pound of air contains .2315 lbs. of oxygen or 4.32 lbs. of air contain 1 lb. of oxygen.

Nitrogen is a colorless gas, diluting the oxygen in the air. Entering the furnace with the oxygen at a low temperature, it passes through the furnace and up the stack, carrying away considerable heat. It is the greatest source of loss in the operation of a steam boiler. Its weight per cubic ft. at atmospheric pressure, temperature at 32° F., is .07831 lbs. A pound of air at the same pressure and temperature contains .7685 lbs. of nitrogen.

Hydrogen is the lightest of all gases, has a great affinity for oxygen, the first claim to the supporter of combustion, and the supposition is that it must be satisfied before any other constituent of the fuel. Its weight per cubic ft. at atmospheric pressure, temperature 32° F., is .00559 lbs.

Carbon is the most widely distributed of all the combustible elements. When brought in contact with oxygen, with an elevation in temperature, a chemical combination takes place. Providing sufficient oxygen is present, each atom of carbon will combine with two atoms of oxygen, forming a compound known as carbon dioxide, the symbol of which is CO_2. The process of this combination may be shown by the formula $C + 2O = CO_2$. The quantity of oxygen present during this reaction may be many times in excess of the required amount but it will not enter into combination with the carbon in a greater proportion than one atom of carbon and two atoms of oxygen.

The combination of oxygen and carbon forming a carbon dioxide gas is therefore the result of complete combustion. From table No. 2 the atomic weight of the combination is easily obtained as follows:

C — atomic weight 12, O atomic weight 16,

$1C + 2O = 12C + 32O = 44CO_2$.

With an insufficient supply of oxygen one atom of carbon combines with one atom of oxygen forming carbon monoxide—CO. This is a colorless gas, and with the addition of more oxygen, providing the temperature is sufficiently high, will combine with another atom of oxygen forming, as already shown, carbon dioxide or CO_2.

Sulphur is found in very small quantities in fuel. It is objectionable, as the gas formed by its combination with oxygen, SO_2, attacks the metal of a boiler, causing corrosion. It has but slight heat value.

Combustion in General.

The two principal elements entering into the combustion of any fuel are carbon and hydrogen. Upon the application of heat a portion of these elements

form a series of compounds termed hydro-carbons, and that portion which does not unite in this combination are known as fixed elements. The condition that exists while the combination of these elements is going on is such that it is impossible to determine the order of dissociation, but we know that the final results of perfect combustion should be carbon dioxide (CO_2), water (H_2O) and nitrogen (N).

(To be continued.)

PRACTICAL MECHANICS—PAPER 13.

Involute Gearing.

In the involute system of gearing we have, instead of the describing circles of the cycloidal system, a describing line which is tangent to a base circle.

If a cord were wrapped around a circular disc and then slowly unwound from the disc, the cord in the meantime being kept tightly drawn, the end of this cord would describe what is known as an involute of revolution. Fig. 14 shows such an involute. The portion of this involute immediately adjacent to the circle is used for the tooth profile.

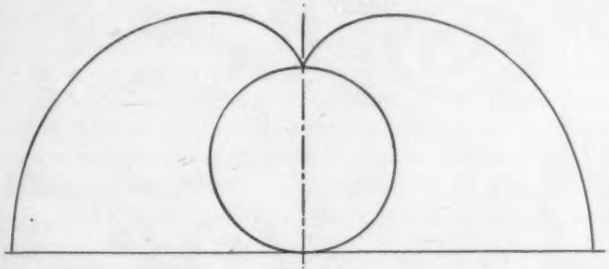


Fig. 14.

Imagine two circular discs rolling together, on which discs are drawn two circles slightly smaller in diameter. Through the point of intersection of the discs imagine a straight line drawn so that it will be tangent to each of the inner circles above mentioned.

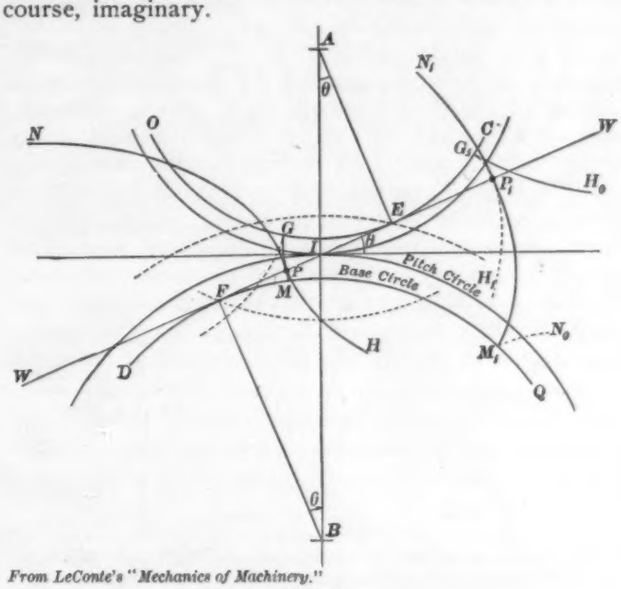
Now if the discs be rotated, thus causing them to roll one upon the other, this common tangent line will move in a constant direction parallel with itself and always tangent to both of the inner circles. It will also constantly pass through the point of contact of the two discs.

Fig. 15 shows two such discs as we have described intersecting at the point I and with centers at A and B. The smaller circles mentioned are designated by the arcs O, E, C and D, F, Q respectively. The line W I W is the tangent line above mentioned, which, as will be seen, is tangent to the inner circles at the points E and F.

Suppose that the two discs are rotated so that the common tangent line W I W will move to the right and upward, i. e., the disc with center B rotating clock-wise; and further suppose that the point F is for the moment considered as a point common to both discs. That is, imagine disc with center A attached to a larger disc such that the larger disc would overlap disc with center A and the circumference of which larger disc is represented by the dotted arc through the point F. As the line moves, due to the rotation above imagined, the point F will move toward I. If successive points were plotted showing actual positions of the point on this line, it is evident that these successive positions will describe an involute on each disc. Such successive positions of a point in the line are shown by the curves G P H and M P N, the point being the describing point.

If the discs were sufficiently extended and the rotation continued far enough, this point P would actually pass through all points on the curve M P N with reference to the lower circle and would pass through all points on the curve G P H with reference to the upper circle. Thus it is seen that the point of contact between two tooth profiles will move along the line from the one point of tangency F to the other point of tangency E.

The inner circles which we have been considering are called base circles, while the disc circumferences are the pitch circles. In actual practice these are, of course, imaginary.



From LeConte's "Mechanics of Machinery."

Fig. 15.

The driving must necessarily all be done between the points F and E and hence the length of the teeth is determined by distance between the base circles. In actual practice the tangent line is ordinarily given an angle of 15° with the common tangent to the pitch circles at the point I. A greater angle of obliquity would permit of longer teeth and a larger arc of action, but would, on the other hand, cause more friction and would, in addition, reduce the strength of the teeth.

It will be seen that, with the involute tooth outline, it is possible to vary the distance between shafts slightly without affecting the constancy of the angular velocity ratio. Such relative movements of the shafts would not affect the base circles and hence their involutes remain unchanged. As the shafts are separated, however, there would be an increased back-lash, and since the angle of obliquity would be increased by such separation, the arc of contact would be greater and the strain would consequently fall nearer the tips of the teeth.

The dimensions of the teeth and other considerations of design may be the same as in the cycloidal system, described in paper No. 12. Therefore, in our next paper, we shall proceed with the practical methods of gear design in accordance with the two systems which we have outlined.

THE WATTHOUR METER.

BY WM. M. SHEPARD AND ALLEN G. JONES.

(Continued.)

CHAPTER VII.

MAINTENANCE AND TESTING.

The care and maintenance of recording watthour meters should receive the most careful attention from distributing companies, and only competent men should be placed in charge of the meter department, because, as pointed out in Chapter I, negligence in the proper care of the meter system may result in a serious financial loss. It is therefore essential that the distributing company be equipped to test and make minor adjustments of its meters. In order to secure the best results it is necessary that some systematic method of inspecting and testing be adopted. Almost all of the larger companies, realizing the importance of meter accuracy, have separate and well-organized meter departments which are equipped for testing, repairing and re-calibrating service meters, this department being held responsible for their proper operation.

With small companies it is often impractical to have a separate meter department, but it will be found, even by the smallest distributing companies, that it is economy in the end to have some systematic method of testing and caring for meters. In small stations, where the size of the system so warrants, it is advisable to employ the entire time of at least one man to see that the meters are kept in proper condition; where this is not warrantable, it can usually be arranged to have the same man do all of the meter work, rather than having two or three men, each doing a part of it, because where there is one man, the responsibility is then definitely placed, and furthermore, he becomes more efficient and he will usually take more interest and pride in seeing that his meters are always in the best of condition.

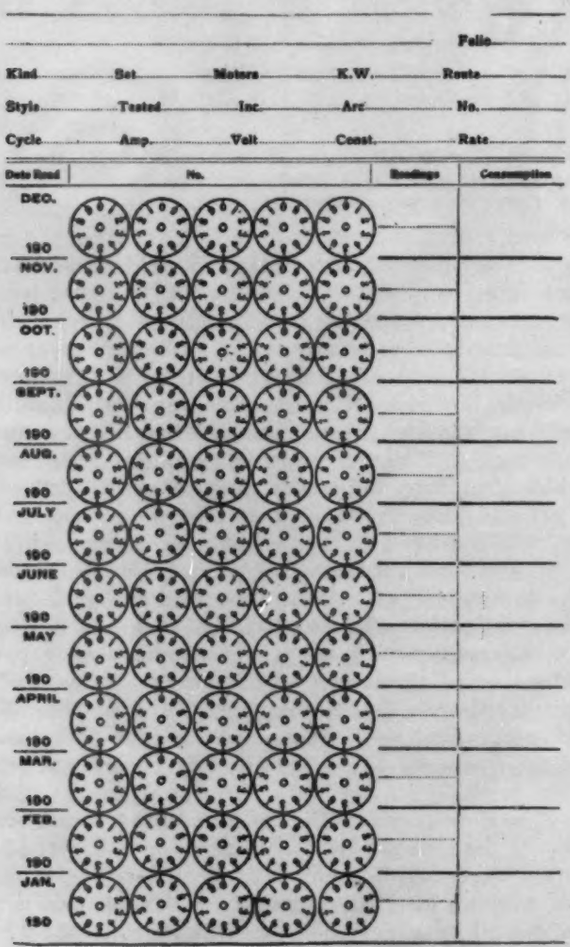


Fig. 80.

Reading the Meter and Keeping of Records.

The interval between the readings of each individual meter should be as nearly uniform as possible, because if the interval is greater for one month than it is for the next, the customer's bill will as a rule be correspondingly affected, which will in a great many cases lead to dissatisfaction on the part of the consumer, with the resulting annoyance and explanations necessary on the part of the distributing company. The best way in which to obviate such troubles, and to insure a uniformity of meter reading is to begin each month at a fixed date and always have the meter-reader go over the route in the same order.

In reading meters it is usual practice to have a special form of "loose-leaf" book which has on each page twelve (or six) facsimile prints of the meter dial, upon which can be marked the corresponding position of the pointers. Such a card is reproduced in Fig. 80, the reverse side of the card being used for any notes which may be necessary. The meter reader should first note the actual reading of the meter and put the figures down in the column set aside for this purpose; he should then copy the exact positions of all of the pointers. By taking both readings thus,

Our No. ..... C ..... Mfgrs. No. .....

Location of Meter .....

DATE READ	READING	READ BY
JUNE	FORWARDED KW	
JULY	KW	
AUG.	KW	
SEPT.	KW	
OCT.	KW	
NOV.	KW	
DEC.	KW	
JAN.	KW	
FEB.	KW	
MAR.	KW	
APR.	KW	
MAY	KW	
JUNE	KW	

Fig. 81.

METER TESTED.....

FOUND.....% FAST.

" .....% SLOW.

LEFT.....

C = dial constant.

OLD FOLIO No.....

" LINE No.....

Rate.....

Min. Monthly Bill $.....

Connected Load.....

.....

.....

Date Read	Reading	Difference	C	K. W. Consumption		Amount of Bill
July	K. W.	K. W.		K. W.	SILENT READINGS	DISC $ NET
Aug.	K. W.	K. W.		K. W.		DISC $ NET
Sept.	K. W.	K. W.		K. W.		DISC $ NET
Oct.	K. W.	K. W.		K. W.		DISC $ NET
Nov.	K. W.	K. W.		K. W.		DISC $ NET
Dec	K. W.	K. W.		K. W.		DISC $ NET
Jan.	K. W.	K. W.		K. W.		DISC $ NET
Feb.	K. W.	K. W.		K. W.		DISC $ NET
Mar.	K. W.	K. W.		K. W.		DISC $ NET
Apr.	K. W.	K. W.		K. W.		DISC $ NET
May	K. W.	K. W.		K. W.		DISC $ NET
June		K. W.		K. W.		DISC $ NET

METER INSTALLED

OUR NO.	MFRS. NO.	C	IN	OUT

Check Meter

Rented Meter Charge

Fig. 82.

one acts as a check on the other, and with a little practice a man becomes efficient and accurate.

Some distributing companies use the form shown in Fig. 81, which does not provide for the check afforded by having both the direct reading and the positions of the pointers copied. There is a great difference of opinion as to the most advantageous method of transcribing the meter readings to the record book. The objections advanced against the method of copying the positions of the meter pointers is the fact that it takes considerably more time than it does to simply transcribe the numerical value direct; it also involves more work on the part of the book keeping organization, and there is also liability of error when the book-keeper transcribes the reading from the meter reader's book to the record book.

The method of simply transcribing the reading numerically is undoubtedly the most rapid and the most satisfactory if a well experienced and careful man can be employed for this work, but the method of transcribing numerically and also copying the positions of the pointers is usually to be preferred on account of the check which it affords.

Figure 82 represents a very convenient form of file-card which may be used for the office records and to which the figures from the reader's book are transferred; the reverse side of the card is similar and the record may be continued thereon. Under no conditions should the record cards be taken from the files.

It is not infrequent that check readings have to be made, sometimes at the request of the consumer and sometimes because of apparent discrepancies in the monthly reading. When such readings are taken it is advisable to use a "re-read" card of a form similar to that shown at (a) in Fig. 83. Fig. 83 (b) shows a convenient form of record blank for use in testing meters.

METER TEST REPORT.

Request Date.....

Name.....

Address.....

Location of Meter.....

Company No..... Size.....Amps.

Mfgr. No..... .....Wires.

Make.....Type..... .....Volts.

Testing Constant.....Reading Constant.....

	FOUND		LEFT	
	% Slow	% Fast	% Slow	% Fast
¼ Load				
½ Load				
¾ Load				
Full Load				

METERED LOAD

2 Cp.	4 Cp.	8 Cp.	16 Cp.	32 Cp.	Arcs	Fans	Misc.

Other Appliances

.....

.....

Remarks:.....

.....

.....

.....

.....

.....

Date Meter Tested.....

.....

Meter Tester.

N. B.—If these Requests fail to follow in Numerical Order promptly advise Accounting Department

Fig. 83a.

Folio ....
Line ....

RE-READ METER

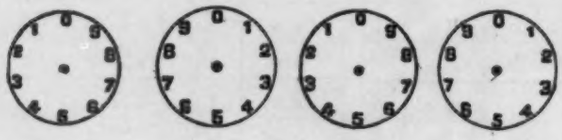
IM—Dec.Co—4m

Date issued .....

Mr. .....

Address .....

Reading { *Watt Hrs.* .....
K. W. .....



Meter Number ..... *Constant* .....

Date Read ..... *By* .....

(Use back of this slip for remarks)

Fig. 83b.

During the regular, or periodic, testing of service meters, there will invariably be found a number of slow meters and it is good policy to use a card similar to Fig. 84, so that the consumer may expect the

DEAR SIR:

Your meter located at .....

being our No. ..... upon being tested has been found ..... % slow. Fearing that any additional billing on your previous consumption would be inaccurate, and possibly unjust to you, we are not rendering any additional bill, but are standing whatever loss has been incurred.

We trust all this is satisfactory.

Yours truly,

Fig. 84.

next bill to vary from the last one. Such precautions involve very little time and expense, and in many cases they save heated arguments and preserve the good will of the consumer.

Too much stress cannot be laid upon the systematic keeping of the data regarding the individual performance of the meters, and for this purpose it is advisable to keep record cards similar to that shown

Date Tested ____ Testing Const ____			Date Rec'd ____ Testing Const ____		
	FOUND	LEFT		FOUND	LEFT
¼			¼		
½			½		
Full			Full		
Date Tested ____ Testing Const ____			Date Rec'd ____ Testing Const ____		
	FOUND	LEFT		FOUND	LEFT
¼			¼		
½			½		
Full			Full		
Date Tested ____ Testing Const ____			Date Rec'd ____ Testing Const ____		
	FOUND	LEFT		FOUND	LEFT
¼			½		
½			¼		
Full			Full		

Fig. 85a.

in Fig. 85, (a) being the front side and (b) being the reverse side. Such data will give an accurate and ready insight into the continued performance of the individual meters, and will act as a guide in the future selection of the best meter for the service of the existing conditions.

ELECTRIC METER RECORD.

OUR NO.	MANUFACTURER'S NO.	MAKE	AMP.	VOLTAGE	WIRE	CONSTANT	TYPE	
DATE SET	READING	NAME		ADDRESS			DATE OUT	READING

Fig. 85b.

Installation of Meters.

With few exceptions, new meters will be found to be well within the limit of good accuracy, inasmuch as they are carefully tested and adjusted at the factory before they are shipped. Before a meter is installed, however, its accuracy should be checked as a matter of record and in order to make any minor adjustments that may be found to be necessary. (In transporting a meter from place to place it is not at all unlikely that the finer adjustments may be affected.) When installing a meter care should be taken, as far as possible, to select an easily accessible place which is free from vibration, jar and moisture, and a place where it will be protected from the weather; it should be installed in such a position that it can be easily read—a point which is too often overlooked. The meter should not be roughly handled during installation or in carrying it from place to place, as it must be remembered that it is a delicate device and should be handled accordingly.

When putting a meter into service care should be taken to see that the moving element does not rest on the jewel bearing until it is installed and ready for operation. The different makes of meters have different methods of accomplishing this result, but in all of them provision is made for protecting the jewel bearing during transportation.

Before a service meter is put into operation it is necessary to see that it is level, since friction is liable to result if this precaution is not taken. (Some manufacturers furnish a small pocket spirit level for this purpose).

Meters should never be located beneath water pipes nor near steam pipes; they should be placed within 8 feet of the floor line so that the periodic testing may be accomplished with the greatest ease.

Meters should not be placed closer together than 15 inches between centers; if placed closer than this they may "interfere" with each other through the effects of stray fields.

Meters should not be installed close to conductors carrying heavy currents nor in the vicinity of iron girders or posts.

The subject of "over-metering" has already been mentioned in several places; as a general rule it may here be stated that for residence lighting the meter should have a capacity of approximately 50 per cent of the connected load; for small store lighting, window lighting, out-door multiple arc lamps, etc., the

meter should have a capacity of about 90 per cent to 100 per cent of the connected load, while for medium and large sized stores this percentage will be approximately 75 to 80 per cent. For metering a motor load, the meter should usually have a capacity of 100 per cent, except where a number of motors are installed, some of which may be running idle or lightly loaded most of the time, in which case a smaller meter could be used. Occasionally it is necessary to install a meter having a greater capacity than the connected motor load, as for instance in the case of hoists and high speed elevators.

A very convenient and reliable method of leveling meters without the use of a spirit-level consists of placing a coin, such as a quarter of a dollar, on the front of the disc and as near to the edge as possible; if the meter is out of "plumb," the disc will move so as to bring the coin toward the side which is the lowest. The meter can then be leveled so that the disc will remain stationary with the coin resting on the front edge; the coin should then be

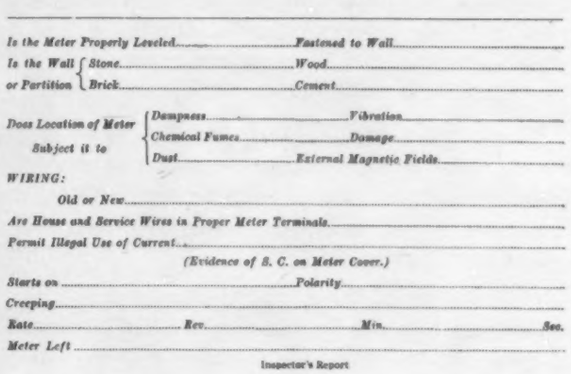

Is the Meter Properly Leveled..... Fastened to Wall.....
Is the Wall or Partition { Stone..... Wood..... Brick..... Cement.....
Does Location of Meter Subject it to { Dampness..... Vibration..... Chemical Fumes..... Damage..... Dust..... External Magnetic Fields.....
WIRING:
Old or New.....
Are House and Service Wires in Proper Meter Terminals.....
Permit Illegal Use of Current.....
(Evidence of S. C. on Meter Cover.)
Starts on..... Polarity.....
Creeping.....
Rate..... Rev..... Min..... Sec.
Meter Left.....
Inspector's Report

Fig. 86.

placed on the edge of the disc in a position ninety degrees from its former position, and the meter then leveled from front to back, without changing the previous adjustment. When the disc is perfectly level, the coin can be placed at any position around the edge, and the disc will remain stationary.

Precaution should be taken to see that the meter is connected properly into the circuit, so that it will rotate in the right direction, especially is this true with polyphase meters, and with single phase meters when used to measure polyphase power. It is not infrequent that two single phase meters are used to measure the power being supplied to polyphase induction motors; the power factor of an induction motor when running lightly loaded is often below 50 per cent, in which case one of the two single phase meters will run backward when properly connected; care should therefore be taken to see that the meters are so connected that both of them will run forward, when the motor is operating at or near full load.

The card shown in Fig. 86, illustrates the form of "Inspector's Report" as used by the Pacific Gas & Electric Co., of San Francisco, Cal., the practice of having a report made out like this for all new installations is to be highly recommended.

(To be continued.)

ECONOMY OF STEAM POWER.

The economic wisdom of making the fullest possible use of an existing steam plant before branching out into gas engines, or purchasing electric current, will be readily admitted as a sound general principle. An example particularly worth noting, being an instance of steam on one side and a choice of gas or purchased current on the other, was recently reported on to a client by E. W. Dean, engineer, of Boston.

The elements of the problem were these: The heating of the hotel and warming of the hot-water supply were done by a steam plant consisting of two Babcock & Wilcox boilers, of 127 and 78 horsepower, respectively. For the water heating, there was a steel tank provided with a thermostatic valve which maintained a uniform temperature. There were also the necessary feed pumps. The condensation in the steam heating system was returned and used again in the boilers.

As to the generators, the requirement was that they should be able to carry the lighting load, start two of the elevators simultaneously, and operate the small motors. There were about 1800 16-c.p. lamps in the house, and the maximum lighting load, as settled by general hotel practice, was that required to operate the lamps, or 900, at one time—50 kw. The maximum electric power required was therefore:

For lighting	50 kw.
" starting two elevators, 50 h.p.	38 "
" operating three motors	6 "
	94 "

A 100-kw. generator, in duplicate, with a 35-kw. generator for use from midnight to some early hour in the forenoon, were recommended. The cost of a gas engine plant was estimated at a total of $27,400, this including $20,950 for three engines, and covering excavating, foundation work, piping, wiring, switchboard and incidentals. The annual cost of operation of gas engines was estimated at $9286, of which $4504 was required for gas used for power, and $3562 for fixed charges on the cost of the engine installation.

Three steam engines were estimated to cost $8408, the total expense of the engines, foundation, wiring, etc., being set at $13,500. The boiler plant and accessories ample in capacity for these engines, was already operating in the hotel. It was estimated that during eight months of the year the whole of the exhaust steam from steam engines could be used for heating feed water, wash water and radiators, and that the engines would be chargeable with consuming 2 lb. of coal per kw.-hour when the exhaust was so utilized; and 7.3 lb. per kw.-hour in the four months when the exhaust was not so used. On the basis of an estimated annual total of 197,586 kw.-hours, the annual coal consumption for the engines would be 372 tons, costing, at $4.34 per ton, $1614. The annual cost of steam power operation was set at a total of $4539, which included $1614 for coal, and $1755 for fixed charges. Comparative costs were summarized as follows:

Cost of installing gas engines	$27,400
Cost of installing steam engines	13,300
Annual cost of operating gas engines	9,286
Annual cost of operating steam engines	4,539
Probable cost of purchased current	8,126

A saving of about $3587 annually by the use of steam engines was demonstrated to be possible in this plant. Gas engines were shown to be more costly for operation than the purchase of current.

JOURNAL OF ELECTRICITY
POWER AND GAS

PUBLISHED WEEKLY BY THE
Technical Publishing Company

E. B. STRONG, President
A. H. HALLORAN, Vice President and Managing Editor
C. L. CORY, Secretary.

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604 MISSION STREET, SAN FRANCISCO

EASTERN OFFICE, 150 NASSAU STREET, NEW YORK
C. N. MANFRED, Eastern Manager

TERMS OF SUBSCRIPTION

United States, Cuba and Mexico	per year,	$2.50
Dominion of Canada	"	3.50
Other Foreign Countries within the Postal Union	"	5.00
Single Copies, Current Month	each	.10
Single Copies, prior to Current Month	"	.25

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Changes of advertising copy should reach this office *ten days in advance of date of issue.* New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal." July 1895.
Entry changed to "The Journal of Electricity." September, 1895.
Entry changed to "The Journal of Electricity, Power and Gas." August 15, 1899.
Entry changed May 1, 1906, to "The Journal of Electricity, Power and Gas," Weekly.

FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

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Super-Heated Steam

The economy effected by the use of super-heated steam is always enticing in theory, but sometimes disappointing in practice. If the temperature of saturated steam be reduced by contact with the cooler walls of the engine cylinder some of it is condensed, thereby lowering the engine efficiency. This condensation may be diminished either by compounding or by using steam jackets, and may be eliminated by super-heating the steam as it leaves the boiler. Such super-heating gives an effective means of increasing the thermo-dynamic efficiency of the engine and the boiler, for it utilizes much heat in the waste gases that is otherwise lost.

The advantages of super-heating are so many and so manifest as to require no mention here. The disadvantages usually come to the surface only when the plant is incorrectly designed or incompetently operated. The chief difficulties experienced are in cylinder lubrication and in the failure of cast iron valves and fittings.

The first is a minor trouble which may usually be traced to the use of low-grade oils which are carbonized by the high temperature of the dry steam. Experience shows that it may be removed by using high-grade oil in an engine especially designed for super-heat operation.

The results of using super-heated steam with cast iron fittings have so frequently proven disastrous that a groundless fear has been implanted in the minds of many engineers. It is asserted that the crushing and crumbling of cast iron valves is due to the high temperature of the super-heated steam, which may reach 600 degrees. So firmly has this erroneous and illogical impression become fixed in the minds of some engineers that it is periodically necessary to bring the matter up for discussion, as was recently done before the American Society of Mechanical Engineers at Boston.

Saturated steam has been debited with many failures of cast iron. The concensus of expert opinion is that this is due not to the high temperature inherent in the steam, but to its extreme heat fluctuations. Under rapid expansion and contraction iron must ultimately wear out. By employing a super-heater designed to deliver steam at approximately constant temperature (a variation of 20 degrees is allowable) competent authorities agree that it is safe to heat the steam to 500 degrees. For higher temperatures open-hearth steel is recommended. English practice sanctions wrought material for all fittings, branches and valve chests distributing super-heated steam. While this is undoubtedly the safer course, it is believed that more trouble with cast iron has been caused by abuse than by use.

PERSONALS.

The Pacific Coast Jobbers' Association met at Del Monte, Cal., April 29, 1910.

George W. Roberts, an electrical supply dealer of Marysville, Cal., was a recent visitor in San Francisco.

R. D. Holabird, of the Holabird-Reynolds Company, of San Francisco, has returned from a trip to Seattle.

H. F. Keyes, manager of the Sacramento Natural Gas Company, was a San Francisco visitor during the past week.

F. E. Vickers, assistant engineer of the General Electric Company's San Francisco office, is making a short Eastern trip.

W. A. Hopkins, electrical engineer for the Safety Car Heating & Lighting Company, of St. Louis, is in San Francisco.

K. G. Dunn, engineer with Hunt, Mirk & Co., of San Francisco, has returned from a trip to Seattle and Puget Sound.

W. F. Lamme, consulting engineer with the Westinghouse Electric & Manufacturing Company's San Francisco office, is visiting Fresno.

W. L. Goodwin, sales manager of the Pacific States Electric Company, has returned to San Francisco from an extensive Eastern tour.

J. F. Turner was recently appointed superintendent of the Fresno., Cal., Traction Company, to succeed Mr. C. B. Jackson, resigned.

D. A. J. Bacon, of Ford, Bacon & Davis of New York, who is president of the Sierra & San Francisco Power Company, is in San Francisco.

Patrick Calhoun, president of the United Railroads of San Francisco, returned last week from an extended tour of the Eastern and Southern States.

Tracey E. Bibbins, assistant Pacific Coast manager of the General Electric Company, has sufficiently recovered from his recent illness as to resume his duties.

Thomas Mirk, of Hunt, Mirk & Co., representing the Westinghouse Machine Company on the Pacific Coast, returned last week from a visit to Southern California.

W. H. Leffingwell, of Bishop, Cal., who is engineer of the Mono Power Company spent the past week in San Francisco on business connected with the projected Owens River development.

C. R. Ray, manager of the Medford lighting plant, of the Rogue River Electric Company's system, has returned to Southern Oregon, after spending several days in San Francisco with his brother, Frank H. Ray.

N. K. Cooper, who was superintendent of distribution for the Independent Electric Light & Power Company and afterwards connected with the San Francisco Gas & Electric Company, has joined the sales force of the Westinghouse Electric & Manufacturing Company, with headquarters in San Francisco.

Will J. Sando has resigned as manager of the pumping engine and hydraulic turbine department of the Allis Chalmers Company, and, after taking a few months' rest, will open an office in Boston, as a consulting engineer. He will also be able to give personal attention to the interests of the Sando Engineering Company of that city.

F. O. Dolson, erecting engineer for the Pelton Water Wheel Company, is at La Grange, completing the installation of an 850 hp. Pelton-Francis turbine wheel, with Pelton governor, direct connected to a Westinghouse generator, for the La Grange Water & Power Company. The new wheel, which operates at 450 r.p.m., under a head of 220 feet, will feed into the Medosto and Turlock lines of the Mt. Whitney Power Company's system.

INSTITUTE MEETING IN SAN FRANCISCO.

The local committee in charge of the meeting of the American Institute of Electrical Engineers, which is to be held under the auspices of the High Tension Committee in San Francisco, May 5th, 6th and 7th, have made arrangements that insure a profitable and a pleasant gathering. In addition to Eastern officers, including President L. B. Stillwell, a full representation is expected from all the Western States.

The meetings will be open to visitors who are not members of the Institute and the interesting papers that have been prepared, together with the entertainment features that are contemplated, make this an auspicious time for electrical men to visit San Francisco. Headquarters will be maintained at the Home Telephone Company's building, 333 Grant avenue.

TRADE NOTES.

The United Iron Works of San Francisco and Oakland, Cal., have been appointed Pacific Coast representatives of The Kerr Turbine Company of Wellsville, N. Y.

Dearborn Drug & Chemical Works announces that after May 1, 1910, their general offices and laboratory will be on the twentieth floor of the McCormick building, Michigan avenue and Van Buren streets, Chicago.

The General Electric Company has sold to the Balakala Copper Mining Company, of Coran, Cal., two 40 hp. induction motors for use in the new installation for the prevention of injurious fumes at the company's smelter.

The General Electric Company has sold to the Northern California Power Company four 40,000 kw. 60 cycle static transformers, stepping up from 6,600 v. to 60,000 v. and the necessary switchboard equipment for one of the company's stations.

The Simpson Lumber Company, which is building a new lumber mill at North Bend, Ore., has awarded a contract for the entire power and mill equipment to Allis-Chalmers Company. The plant will be dziven by a 20 x 36 "Reliance" type heavy-duty belted Corliss engine.

The Canadian Westinghouse Company has been awarded the contract for a 1,000 kw. motor-generator set by the British Columbia Electric Railway Company of Victoria. The apparatus will be used for railway service in connection with the Jordan River Hydro-Electric transmission plant, now being installed by Sanderson & Porter.

John Hanbury of Vancouver, B. C., is building a new lumber mill, which will be of the modern Pacific Coast type and equipped throughout with electric drive. Allis-Chalmers Company has been awarded the contract for the entire equipment, including both sawmill and power machinery. A 500 kw., 480 volt, 3 phase, 60 cycle 3,600 r.p.m. steam turbo-generator will furnish power.

Two 715-h.p. Pelton-Francis turbines operating under 51-ft. head and running at 300 r.p.m., will be furnished to the Consumers' Power Co., Cannon Falls, Minn., each unit consisting of two spiral-encased Pelton-Francis wheels with central discharge draft elbow. Each turbine will be equipped with a 4-ton flywheel and a type "C" Pelton oil pressure piston type governor. An exciter water-wheel of 60-h.p. capacity, 600 r.p.m., is included in this contract; the exciter water-wheel also to be regulated by Pelton oil pressure governor. The Consumers' Power Co. has also placed contract with the Pelton Co. for two 1100-h.p. turbines of similar design to the above mentioned turbines and operating under the same condition, except that the flywheel will weigh about 6½ tons each, the exciter being of 90-h.p. This company carries on a general power and transmission business and provision for additional Pelton-Francis equipments is being made for their installation at a later date.

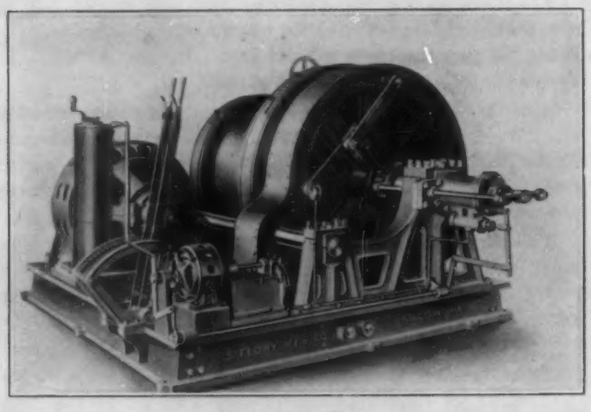
INDUSTRIAL

ELECTRIC MOTOR DRIVEN MINE HOISTS.

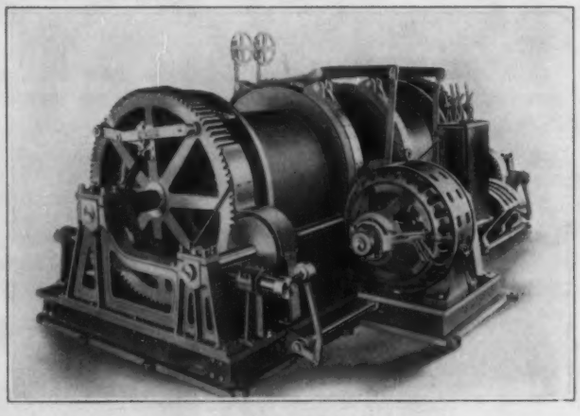
Since the cycle of operation in any hoisting proposition is of an intermittent character, the power required is at a maximum only a part of the time, even though the hoist be operated practically continuously. In many cases the hoist is in operation only a very small part of the day. These conditions offer special advantages from an economical point of view for the use of electric motor-driven hoists. The electric hoist is always ready, and uses power only in proportion to the load handled when it is in actual operation.

The bearings are self-oiling and the motors seldom require any other attention than an occasional inspection and cleaning. There are no complicated parts to get out of order or to require continual oiling, packing, etc. The electric hoist may be operated by almost anyone, as no previous experience or mechanical knowledge is required and an engineer's license is unnecessary.

The single and double drum electric motor-driven mine hoists of the S. Flory Manufacturing Company, Bangor, Pa., are well shown by the accompanying pictures. These hoists,



Single Drum Hoist.



Double Drum Hoist.

which are especially designed for mines, quarries, planes, shafts, etc., are equipped with I. O. Werner patent band friction and are driven by Westinghouse motors.

The patent band friction is of special design and possesses many features of superior merit. It is actuated through different members; the gear, drum, rocker shafts and strap bands. The strap bands tighten on a cast rim on the drums and are actuated by shafts which have double stub ends and are connected to the ends by jaw ends and turnbuckles. The lever arms are keyed to the rocker shafts on opposite ends and are actuated by the levers which move around fixed points on the gear. Slides are secured on the gear supporting the lever arms. The slides are actuated through a sleeve on the main drum shaft and two radial arms which are secured to the slides. The frictions are thrown in and out of contact by means of hand levers in a battery, as shown by the cut of the double drum hoist, or by an air cylinder using an equipment similar to street railway car air compressors, as shown by the picture of the single drum hoist. By moving the sleeve to the gear the slides are actuated in a radial direction that operates the stub levers and rocker shaft; this causes the band to grip or tighten on the brake flanges of the drums. The reverse motion of hte sleeve releases the friction. A strong claim is made for the gripping device. After the frictions are thrown into contact, they will positively remain in this position until released. The drum and gear form a unit and can be operated as a reverse motion hoist without producing any end strain on the bearings; the value of which is obvious. When the frictions are thrown out of contact, the drums are loose on the shaft and will revolve free at high speed when lowering or paying out the rope.

The single drum hoist is shown with a Westinghouse electric railway air compressor and air reservoir mounted on the base of the hoist. The reservoir is ocnnected to the air cylinder at the end of the drum shaft. The air valves are actuated by a lever shown close to the battery of two levers and controller. Very little exertion is required by the motorman to throw the friction in and out of contact as it is of the toggle type. After the air compressor is put on the contact continues until the friction is reversed by the reverse motion.

The drums are turned off smooth or machine spirally grooved for any size wire rope, and mounted on a self-contained cast-iron base arranged to receive the motor and controller. The drums for long planes or heavy lowering are equipped with asbestos brakes made out of long fibre material. The blocks are formed in sectors with iron flanges, securely bolted under high pressure, and treated with oil. They are secured between cast-iron flanges and surrounded with steel bands of the differential type. The brake bands are operated with hand levers in notched quadrants fitted with thumb latches, and are thereby securely held in any position. The advantage of asbestos brakes for long planes or shafts is decided.

The single-drum hoist shown by the photograph was installed at the Bliss Collier[illegible] D. L. & W. Company. The drum is 60 inches in diameter; 48 inches long between the flanges, and is designed for an 8,000 lb. rope strain at a speed of 500 ft. per minute. The hoist is operated by a Westinghouse type "HF" 150 hp. alternating current motor. This type of induction motor is especially suited for application where a strong starting effort is needed. It is well adapted for use on circuits carrying lighting loads, as the starting of it does not appreciably affect the voltage regulation. These motors are controlled by standard Westinghouse single handle, reversing, drum type controllers which insert resistance in the secondary at starting and gradually cut it out as the hoist speeds up; the controller has a large number of points that give smooth acceleration. When the controller is in the off position, the motor is entirely disconnected from the line.

The double-drum hoist shown was installed for the Bessemer Coal, Iron and Land Company, Messins, Ala. It is connected to a Westinghouse 125 hp. motor of the same type.

AN IMPROVED TYPE OF SPEED CONTROLLER.

Absolute reliability is a feature of the General Electric Company's CR 162 speed controller. Very often the control of shunt wound direct-current motors is accomplished by the use of two rheostats, one for starting the motor and the other for varying the motor field current for speed control. In the CR 162 speed controller these two rheostats are combined in one box and operated by the movements of one and the same rheostat arm.

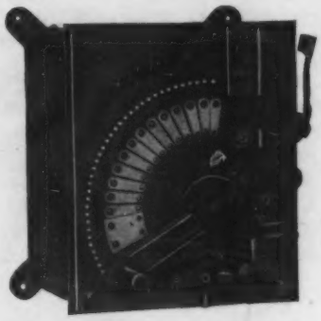


Fig. 1. Speed Controller. 35 hp. 115 Volts.

This device consists of a starting rheostat, the arm of which is provided with a projection carrying a sliding contact which moves over the contact buttons connected to the field resistance. An auxiliary arm on the right-hand side of the rheostat front serves to maintain a short circuit on the field resistance during the period of starting the motor, and on the starting resistance, when the arm is turned back to vary the running speed of the motor by regulating the field current.

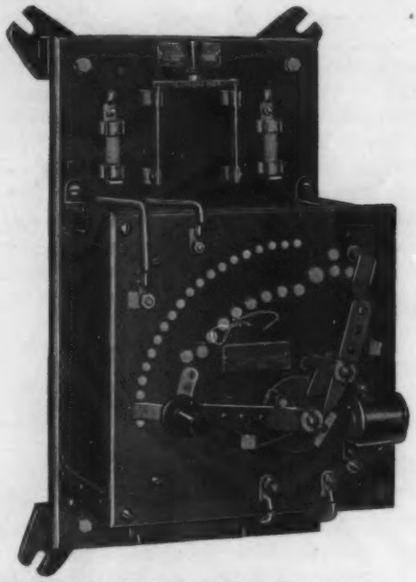


Fig. 2. CR 144 Speed Controlling Panel.

When starting the motor, the starting arm can not be left in any position on the contact buttons, due to the action of a spring, but must be turned to the right until it engages the auxiliary arm forcing the latter to be retained by the no voltage release coil. The auxiliary arm then withholds the spring actuating the starting arm and thereby makes it possible to leave the arm in any position on the field contacts, which will give the desired speed control of the motor. If the operator releases the rheostat arm at any position while it is being moved to the right during the starting period, it will immediately return to the off position. Upon failure of voltage the retaining coil is demagnetized, releasing the auxiliary arm, which in turn releases the spring which carries the starting arm to the off position, thus opening the motor circuit.

The rheostat is so designed that it requires a little extra pressure to move the arm beyond the maximum speed point, the object being to call the operator's attention to maximum speed position so that he will not unintentionally shut down the motor. When it is desired to stop the motor the switch-arm is thrown to the off position, deenergizing the retaining magnet and releasing the auxiliary arm which then opens the motor circuit. The maximum attainable speed variation is 3:1.

CR 163 starting and speed-controlling rheostats are the same as CR 162, with the addition of an over-load release coil. Either 162 or 163 controller can be supplied mounted on a slate base, together with a double-pole switch and fuses, and are then known as CR 144 universal speed controlling panels.

A NEW TELEPHONE MOUTHPIECE.

The ordinary composition or hard-rubber mouthpiece is easily broken and a source of considerable expense to a company in the course of a year. The ordinary steel mouthpiece removes this objection, but it is dangerous, as it is a ready conductor of electricity and source of danger during storms or through crossed wires. The common metal mouthpiece is affected by dampness and corrodes easily.

Taking these things into consideration, the Kellogg Switchboard & Supply Company has combined the advantages and eliminated the objections of the two styles, in the design of their new reinforced rubber covered steel mouthpiece. This mouthpiece has a perforated steel shell, covered with a coating of hard rubber, moulded over it at great pressure and heat. As the rubber is forced through the perforations and around the shell, it makes an absolutely unbreakable mouthpiece. The threaded portion is made directly on the steel at the base, eliminating danger of breakage at a point where most rubber and composition mouthpieces give way.

TELEPHONE DISPATCHING TRAINS IN THE NORTHWEST.

The Great Northern Railway, which at the present time is using the telephone to dispatch its trains on divisions covering approximately 2100 miles of its line, is now planning on a further extension of this system.

Orders have recently been placed for telephone train dispatching apparatus to be installed on six more divisions, viz.: Fergus Falls, Breckenridge, Northern, Dakota, Saint Cloud and Cascade divisions, covering a total of approximately 1,900 miles. As these divisions are among the most important and busiest of the whole railway—thirteen dispatchers being required to handle the large amount of traffic—it can easily be seen that this method of train dispatching has taken a firm hold upon the Great Northern Railway officials.

The apparatus to be installed will be the Cummings-Wray selectors and Western Electric telephones, as this style of equipment has been adopted as standard by this railway, and is now in use on the present circuits. Two hundred and ninety stations will be completely equipped for the new class of service.

An interesting feature of this installation will be the placing of telephones at sidings and at stations which are not open during the whole 24 hours—three hundred and fifty telephones being required. While the train crews in this way can reach the dispatcher at any time, the important fact is that the dispatcher can get in touch with the train crews waiting at any siding, thus enabling him to give orders, prevent congestion, and keep the traffic moving.

When the proposed equipment has been installed, the telephone train dispatching system of the Great Northern Railway will extend over the entire main line from Minneapolis and Superior to Seattle and Vancouver.

NEWS NOTES

INCORPORATIONS.

FRESNO, CAL.—The Modern Electric & Fixture Company has been incorporated, by H. H. Cartwright, W. F. Bledsoe and J. H. Blake, with a capital stock of $25,000.

LEWISBURG, ORE.—The Lewisburg Mutual Telephone Company has been incorporated, by E. Bowen, G. H. Thompson and W. J. Haberly, with a capital stock of $1,173.

MARYHILL, WASH.—The Maryhill & Goldendale Railway Company has been incorporated by S. Hill, H. C. Richardson and N. D. Miller, with a capital stock of $10,000.

LOS ANGELES, CAL.—The Fair Oaks Water Company has been incorporated by G. H. Chase, L. Wooster, P. A. Kilfoil, M. C. Fenn and others, with a capital stock of $75,000.

CALDWELL, IDA.—The Caldwell-Roswell Interurban Railway has been incorporated for $250,000 by H. W. Dorman, for the purpose of building the proposed electric line between this place and Roswell.

TACOMA, WASH.—The Sound Telephone Company of Pierce County has been incorporated with a capital of $5,000 by W. S. King, B. B. Sampson, A. M. McGoldrick, S. S. Watkinson and Edgart Wheeler.

PORT TOWNSEND, WASH.—E. A. Sims, of this place; Eric Molander, Everett; James H. Causten, James A. Calvert and Wm. B. Martin, Seattle, have incorporated the Olympic Power & Development Company, with a capital of $250,000, to supply Port Townsend and Irondale with electric power and water from the Dungeness, Quilcene and Dosewallips rivers; also to conduct an interurban car system between the two places.

TRANSPORTATION.

McMINNVILLE, ORE.—The Oregon Electric will lay tracks and build a depot at this place. Franchise having been granted.

WALLA WALLA, WASH.—It is announced that the Northwestern Corporation will build an interurban line between this place and Pasco.

RIVERSIDE, CAL.—An application from J. S. Jackson to construct a single track railroad for a term of 49 years in the County of Riverside, has been presented.

TACOMA, WASH.—Improvements under way for The Tacoma Railway and Power Company and the Puget Sound electric line this season will cost about $200,000.

SPRINGFIELD, ORE.—The City Council has accepted the bonds of the Lane County Asset Company to build the Willamette Valley electric line into this city within 24 months.

VANCOUVER, B. C.—J. W. Pike of this place has been awarded the contract for building the prairie section of the B. C. E. R. line on the Chilliwack extension, a distance of five miles.

GLOBE, ARIZ.—The Cananea Consolidated Copper Company is adding two 1,500 kw. horizontal Curtis turbines to the power plant at Smelter. They are remodeling the boiler plant and fitting it with Foster superheaters.

MARSHFIELD, ORE.—The officials of the Coos Bay Rapid Transit Company, recently organized to build an electric line from this place to North Bend, announce that work of building the line will be started as soon as franchises are secured in the two cities.

SAN FRANCISCO, CAL.—The Supervisors have passed the following resolution: "Directing the clerk of this board to advertise a notice for the sale of the Geary Street Railway bonds, issue of July 1, 1910, to the amount of $200,000, comprising thirteen bonds of each year's maturities, 1915 to 1934, inclusive. The sale is to be held May 16, 1910, at the hour of 3 o'clock p. m.

OAKLAND, CAL.—Grading for the new electric suburban system, which is to connect Contra Costa County with Oakland, was commenced last week at Walnut Creek. The road is known as the Oakland and Antioch Railway. The projectors plan to build it from Bay Point, through Concord, Walnut Creek, Lafayette, by way of the tunnel road, into Oakland. Fred Brooks, engineer in charge of the construction work, has announced that the plan is to complete the line this fall.

SACRAMENTO, CAL.—That construction work will be started by July 1st of this year, and that under favorable circumstances train service will be begun inside of a year is the prediction of Manager F. A. Warner of the Sacramento and Sierra Railway. The new railroad, which will be constructed from Sacramento to Lake Tahoe, primarily for the purpose of opening up a vast territory of rich timber land, and at the same time affording easy access to market of the products of Coloma, El Dorado County. There have been some delays in the last six months over obtaining the necessary rights of way, but only a few deeds are still unsigned. The exact route of the new railroad is as follows: From Sacramento the roadbed will run through Ben Ali, directly north of Sacramento, thence to Orangevale northeasterly, north to Rattlesnake Bar on the American River, thence to Pilot Hill and on to Cool, and thence directly east to Greenwood, Georgetown and so on to Jackson Spring and Lake Tahoe. The road will be a trifle more than 79 miles long. Running beyond Georgetown, the Sacramento and Sierra Railway will strike the vast timber belt of northern El Dorado County. One hundred and fifty thousand acres belonging to C. A. Smith, the lumber magnate, will be tributary to this road, and there are vast tracts which will thus have a direct communication with the markets by way of Sacramento. Manager Warner has called attention to the fact that a bid will be made for summer tourist travel to Lake Tahoe after the completion of the road.

TRANSMISSION.

LEWISTON, IDA.—The Kooskia Milling & Power Company will soon begin the work of repairing its dam, badly damaged by recent floods.

FOREST GROVE, ORE.—The Haines Power Company will extend its lines to Hillsboro. It will furnish light to the small towns between the two cities.

ILWACO, WASH.—The North Bend Light & Power Company has taken over the holdings of the Ilwaco Electric Light Company and will make many additions and improvements in same.

NELSON, B. C.—The International Electric Company, Ltd., with head offices here and with a capital of $1,000,000, has applied for incorporation to develop hydro-electric power from the falls at the junction of the Salmon & Pend d'Oreille rivers north of the boundary.

NORTH YAKIMA, WASH.—It is announced that when the Northwestern Light & Power Company and the Yakima Valley Power Company, the interests of Robert E. Strahorn,

are taken aver by the Northwestern Corporation, in the near future an extension of the transmission system will be made, connecting the Northwestern plant at Walla Walla with the power line at Pasco. Other improvements will be made.

REDDING, CAL.—The Northern California Power Company has brought a condemnation suit against Mr. and Mrs. D. L. Covey, of Whitmore, whereby it seeks to acquire 188 acres of land now held by the Coveys and which they refuse to sell at what the power company claims is a fair price. The Northern California Power Company, according to the complaint, purposes to make a storage reservoir of 1,540 acres on the Dry Burney Creek, eight miles from Kilarc, in a straight line. A dam 238 feet high will be built, and this will restrain water to a depth of 35 feet over this two and one-half square mile area, for the land is nearly level. By private purchase the company has acquired 1,352 acres from Thomas B. Walker, Edgar Firth, David Covey and L. B. Gordon.

ILLUMINATION.

ODESSA, WASH.—An electric lighting and power system is soon to be installed here, by the Washington Water Power Company.

ELLENSBURG, WASH.—A. E. Wright of Olympia has been granted a 50-year franchise to sell gas for illuminating and fuel purposes here.

SEATTLE, WASH.—The Seattle Lighting Company has filed plans for the construction of a $3,500 concrete foundation for a gas tank at 6350 Wellington avenue.

LOS ANGELES, CAL.—The Johnnie Mining and Milling Company, of which T. A. Johnson is manager, will install electric power and increase the capacity of its plant.

ELLENSBURG, WASH.—The City Council has granted A. E. Wright of Olympia a 50-year franchise to sell gas for illuminating and fuel purposes in the city of Ellensburg.

SPOKANE, WASH.—The Spokane Falls Gas Company will spend about $35,000 in enlarging its plant and laying new mains. A contract for improvements has been let.

CHICO, CAL.—An ordinance has been passed by the Board of Supervisors granting to W. H. Hanscom and J. H. Kimball a franchise for the right to erect and maintain poles for a power line.

RICHMOND, CAL.—H. B. Kinney, manager of the Richmond Light Power Company, has presented a petition asking that a franchise be granted to his company, allowing them to lay mains through the city.

SAN BERNARDINO, CAL.—The Victor-Virgin power plant, at Needles, which has not been in use for several years, is about to be put in shape to furnish power to mines and for other purposes, by C. H. Burlock of San Diego.

OLYMPIA, WASH.—The City Council has granted to H. H. Hyde a gas franchise for a period of 50 years, for the use of streets and avenues for the purpose of constructing, maintaining and operating a plant and system for the manufacture and sale of gas.

GLOBE, ARIZ.—The Globe Light & Power Company is installing a 100 kw. General Electric generator direct connected to Williams Monogram engine. This is the first engine of the kind to be installed in the West. This company is adding 60,000 ft. holder two purifiers, exhauster and station meters to the gas plant at Globe.

LOS ANGELES, CAL.—The ornamental lighting of Seventh street from Hoover to Boyle streets, a distance of four miles, and to Sixth street, from Main to Alameda streets, has been approved by the Streets Committee. The property-owners have to pay for the ornamental post and for the electric current on the alternate years.

OAKLAND, CAL.—The erection of electroliers on Fourteenth street, between Castro and Market streets, and on Market, between Thirteenth and Fourteenth streets, has been recommended to the City Council by the Public Service Committee. Electroliers will also be erected along the length of Twenty-third avenue, from East Twelfth to East Twenty-third street.

LOS ANGELES, CAL.—Contracts have been let and pipe ordered for the building of the Domestic Gas Company's pipe line from Los Angeles to San Bernardino, and work will be started about July 1st. The line will run out through Boyle Heights and follow the line of the Pacific Electric Company to Covina. From there it will go direct to Pomona, and then on to Ontario and Uplands, supplying both of these towns with gas. From these it will take a direct shoot to San Bernardino.

SAN BERNARDINO, CAL.—The laying of the high-pressure gas mains for the San Bernardino Valley Gas Company will commence at once. As soon as the line to Colton is in commission the company will dismantle the Colton gas plant which is to serve the entire valley, Riverside and Corona, and the line now being built to supply Colton from here will be used in supplying San Bernardino from the central station. More than $500,000 will be expended in laying the system in the valley.

RICHMOND, CAL.—War has broken out between the Oakland Gas, Light and Heat Company and the Richmond Light and Power Company. The struggle follows the failure of negotiations when H. B. Kinney, manager of the Richmond company started to buy gas at wholesale from the Oakland corporation. Kinney's offer was not accepted. Thereupon he announced that his company would build a plant and go into the gas business. The rate charged by the Oakland company has been $1.50 a 1,000 cubic feet, as fixed by the City Council. Kinney says that he will spend $200,000 in installing a gas manufacturing plant.

SANTA BARBARA, CAL.—One of California's new laws may have an early opportunity to be tried in Santa Barbara. The Council, in meeting to decide upon an increased gas rate, was informed by E. D. Berri that the referendum would not be long in following the decision of the Council in increasing the gas rate of the Santa Barbara Gas and Electric Company (Edison) from $1 to $1.25. The meeting was attended by a number of citizens all protesting against the proposed rate. The Council extricated itself by resolving that this rate should be made only after the company has spent $100,000 in improving the plant and when a first-class pure gas of even pressure is being manufactured. The main object of attack was the report of Prof. C. L. Cory, a San Francisco gas expert, who was brought here by the Council to determine the value of the plant so that a rate could be placed by which a fair return could be had by the company. Cory's report was favorable to the company.

TELEPHONE AND TELEGRAPH.

EVERETT, WASH.—The City Council has started a move to have telephone wires put underground in the city.

DAVENPORT, WASH.—Telephone franchises have been granted to J. M. Palmer over certain roads from Lamona and Odessa.

DILLON, MONT.—The Southern Montana Telephone Company has decided to increase its capital stock from $10,000 to $40,000 and will make numerous extensions.

NAPA, CAL.—It has been ordered that C. A. Henne be granted permission to install a telephone line from St. Helena Sanitarium to his place, commonly known as the "White Cottage."

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